Journal of the
Royal Microscopical Society

CONTAINING ITS TRANSACTIONS AND PROCEEDINGS

AND

A SUMMARY OF CURRENT RESEARCHES RELATING TO

ZOOLOGY AND BOTANY
(principally Invertebrata and Cryptogamia)

MICROSCOPY, &c.

EDITED BY

R. G. HEBB, M.A. M.D. F.R.C.P.

WITH THE ASSISTANCE OF THE PUBLICATION COMMITTEE AND

J. ARTHUR THOMSON, M.A. LL.D.
Regius Professor of Natural History in the University of Aberdeen

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Plate I. Alcide d'Orbigny, from a lithograph by Lavallée (1839).

JOURNAL

OF THE

ROYAL MICROSCOPICAL SOCIETY.

FEBRUARY, 1917.

TRANSACTIONS OF THE SOCIETY.

I.—*Presidential Address, 1916–17: Alcide d'Orbigny, his Life and his Work.*

By Edward Heron-Allen, F.L.S. F.G.S. F.Z.S. P.R.M.S. M.R.I.A., etc.

TO WHICH IS APPENDED

A Study of the Foraminifera of the Biscayan Coast of France in the Neighbourhood of La Rochelle.

By Edward Heron-Allen and Arthur Earland.

(*Read* January 17, 1917.)

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Introduction.

The verdict of posterity upon the work of d'Orbigny was anticipated by Geoffroy-St. Hilaire and Latreille [1] and by de Férussac [2] when they announced to the scientific world in 1825 that "the Order of the Foraminifera was a creation of d'Orbigny," and it was pronounced by Parker and Jones in 1871 when they said: "with all its faults, and they are neither few nor small, the 'Tableau Méthodique' by Alcide Dessalines d'Orbigny [3] must be regarded as the alphabet of the Nomenclature of the Foraminifera"; [4] by Van den Broeck in 1876, who said: "le 'Tableau Méthodique,' malgré ses nombreuses imperfections n'est pas moins, pour son époque un rémarquable monument de sagacité," [5] and,

[1] XVI., p. 818. [2] I., p. 117.

[3] D'Orbigny's Christian name has been shrouded in some confusion. There is no doubt he was baptized Alcide Charles Victor Marie (XXII., p. 3; XXI., p. 434), but he adopted in his earlier works his father's family, or rather territorial, name, and he describes himself as "Alcide Dessalines d'Orbigny fils" on the labels affixed to the boxes in which his "Models" were issued, and so signed the autograph dedication on the fly-leaf of the copy of the catalogue presented by him to the Museum at La Rochelle (XXIII., p. 160). In the "Tableau Méthodique" he calls himself "A. Dessalines d'Orbigny" (p. 96) and "Dessalines d'Orbigny" (p. 245), but in the Monographs of 1839 and 1846, and in all his later geological works, he is called merely "Alcide d'Orbigny."

[4] XX., p. 145.

[5] XXIII., p. 170; E. van den Broeck. Foraminifères de la Barbade, Brussels, 1876, p. 51.

before them, by Carpenter in 1862, who said: "as his labours have contributed far more than those of all his predecessors put together, to the extension of our knowledge of the diversified forms belonging to this group, it was most unfortunate that they should have been commenced and carried on under the influence of views regarding the *value of characters* which have since proved to be altogether erroneous."[1]

The fundamental errors of classification, and his riotous exuberance of nomenclature have, however, long ago ceased to be pitfalls, or even stumbling-blocks in the way of the student. Almost every line that he ever wrote upon the Foraminifera has been subjected to the most minute and learned examination and analysis; as we shall see, the whole of his species, with the exception of three, have been figured or described (or both), and his work stands to-day, as one of his latest biographers has said, if not as the basis, at least as the point of departure of all modern work and research upon the subject.[2]

The Memoir which follows was originally undertaken under the impression that it might be completed within the recognized compass of a Presidential Address. But very soon I realized that to do anything approaching justice to the task which I had undertaken, the limits I had set myself must be very widely expanded. For many years the somewhat nebulous personality of Alcide d'Orbigny has exercised a significant fascination for me, and I found that I had collected a far larger mass of data and documents than I had any idea of. "Bonum est cribrare modium sabuli ut quis inveniat unam margaritam"—with these words quoted from Averroës, Benvenuto da Imola commences his Commentary upon the Paradiso of Dante,[3] and such pearls as I have extracted from many "modia" of sand, are collected in something approaching to order in the following pages.

I.—Early Years and Studies at La Rochelle.

Alcide d'Orbigny was born on September 6, 1802, at Coueron (Loire Inf.). His father, Charles Marie Dessalines d'Orbigny, was of West Indian origin, and has been traditionally, but erroneously, reported to have been a "descendant" of Dessalines, the notorious rebel-chief of San Domingo.[4] He was born in 1770 (January 2) on board ship whilst his parents were travelling to that Island from St. Malo, and his birth was registered at Port Malo in San

[1] XVII., p. 5. [2] XXIII., p. 170.

[3] Commentum in Dantis Comœdiam, Vernon and Lacaita's ed., Florence, 5 vol. (1887), iv., p. 291.

[4] See Appendix A for the origin of this legend, and the history of the family.

Domingo.[1] (See Appendix A.) He was sent to France to be educated, and so escaped the massacre by which his parents and sixteen brothers and sisters perished in the insurrection of the slaves, and at the age of fifteen he became assistant in surgery on board the 'Ariel' and the 'Refléchie' in the French navy, and later we find him working as a naval surgeon attached to the port of Brest, and the naval hospitals of Lorient and Paimboeuf. As surgeon-major of the French Expeditionary Force to Ireland in 1798 he was attached to the hospitals for French prisoners in this country, and on his return in 1799 he married, at Paimboeuf, Marie-Anne Pipat, the mother of Alcide d'Orbigny, residing successively at Coueron (Loire Inf.) and at Noirmoutier (La Vendée). We have good reason to spare a little time to record the result of our researches into the life of Charles d'Orbigny, for it is to him that the world owes the foundation of our study. In 1815 he removed his family and practice to Esnandes, a little village on the Anse de l'Aiguillon, 13 kil. north of La Rochelle, near the Pointe S. Clément.[2]

Esnandes is a very remarkable village, consisting of hardly more than a street running up from the Anse de l'Aiguillon, an immense shallow-water bay, from which, at low water, the sea recedes for miles. The local industry is the cultivation of mussels, which are grown on curious "parks" or traps, formed of faggot hurdles planted in the soft mud in the form of triangles pointing out to sea, with a small opening at the apex, across which nets are drawn as the tide recedes (Plate II). These "bouchots," as they are locally called, become thickly covered with mussels, and the "boucholeurs" go out at low tide across the mud in little punts, called "acons," 2 or 3 m. in length and only 50 cm. broad, which they propel by kneeling in the "acon" on one knee, whilst they propel it with the other leg cased in a long boot which serves as oar, anchor, and rudder (Plate III). The spectacle of hundreds of these queer craft scurrying home across the mud at the turn of the tide (which comes up like a mill-race) is a most unforgettable sight.[3]

The elder d'Orbigny wrote a pamphlet upon this industry of

[1] The published biographies state that he was born at St. Malo (Ile et Vilaine), an error gathered from an official document in which the writer, being unaware of the existence of Port Malo, St. Domingo, imagined that he was correcting an error in inserting St. Malo (Ile et Vilaine).

[2] His family consisted at this time of five sons and one daughter—his eldest child—Mlle. Estelle Marie d'Orbigny, born in 1800, who died at La Rochelle in 1893 (XXII., p. 2; XXIV., p. 355). See Appendix A.

[3] XXIV., p. 355. See also the "Guide Joanne" for La Rochelle (1914 ed., p. 27) and the local "Guide" published by the "Syndicat d'Initiative de La Rochelle" (1913–14, p. 58). The immediate market or centre of distribution is Bordeaux. D'Orbigny tells us that the mussels being thus kept, "as one might say in a state of domesticity, they acquire a more delicate flavour than the 'wild' variety" (XI., p. 89).

the neighbourhood of La Rochelle, from which we learn that it was founded in 1035 by an Irishman named Walton, who was cast ashore by a shipwreck at Esnandes. We have it on the authority of Alcide d'Orbigny, writing in 1845, that the mollusca of the neighbourhood forms or formed the entire and exclusive food of the inhabitants;[1] I am happy to be able to record, however, that the travelling scientist who visits the locality is not necessarily debarred from a carnivorous diet.

A more propitious locality for Foraminifera to flourish in can hardly be imagined. For the ordinary tourist, however, the feature of Esnandes is a remarkable crenelated and battlemented Roman church, fortified in Gothic times (twelfth to thirteenth centuries), the castellated choir being added in the fifteenth century (Plate IV). The whole was restored in the nineteenth century. There are several such in the neighbourhood, which served as Huguenot fortresses in the times of religious upheaval through which La Rochelle has passed in the sixteenth and seventeenth centuries. Close by is the objective point of a pilgrimage which I made to Esnandes in May 1914. A broad gateway giving access to a large courtyard forms the approach to a substantial house of the yeoman farmer type, which was originally the clergy-house of Esnandes, but that parish being linked with the neighbouring one of Marsilly, it was let to Charles d'Orbigny, and it was here that his collections, destined to form the nuclei of the Musée Fleuriau de Bellevue at La Rochelle and the Musée de Paléontologie at Paris, were accumulated and stored.[2] An excellent etching of the house was made by E. Conneau in 1889, which was published in the paper of Beltremieux (Bibl. XXIV.). Mons. L. Musset has made for me a new drawing of the house, which is here reproduced (Plate V). In this house Charles d'Orbigny and his family lived until 1820, when he removed to a house in the Rue des Prêtres at La Rochelle, which is to-day, in honour of him and of his son Alcide, called the Rue d'Orbigny.[3] The writer of the biography of Alcide d'Orbigny in Larousse[4] says that he was a pupil at the Lycée of La Rochelle, but regard being had to the distance between Esnandes and La Rochelle, and to the fact that Alcide d'Orbigny was eighteen years old when his family removed to the latter town, I think this is doubtful.

[1] "Les habitants des bourgs entiers d'Esnandes, de Marsilly, et de Charron, pres de La Rochelle ne se nourissent que de coquillages" (XI., p. 89, note 2).

[2] When the d'Orbigny family first arrived at Esnandes they occupied for a few months a smaller house on the shore of the Anse de l'Aiguillon which was demolished many years ago.

[3] Labonnefon records that the departure of the d'Orbigny family from Esnandes was hastened by the fact that the d'Orbigny house was the "presbytère" of Esnandes (as above related), and that the Curé at Marsilly wished to take up his residence there. The elder d'Orbigny was requested to give up possession of the house by the Conseil Municipal on December 4, 1820.

[4] Dictionnaire Universelle du XIX. Siècle, xi. (1874).

These years saw the foundation of the study of the Foraminifera. Charles d'Orbigny, apart from his profession as a doctor, occupied himself with scientific studies, corresponding with workers in all parts of the country, and in Paris. He was attracted by the study of the Foraminifera, and collected sands containing them from various localities, and it would appear that as his eyesight deteriorated, he had them examined primarily by his son Alcide.[1] He had received from the geologist Fleuriau de Bellevue several packets of sand from Rimini on the Adriatic, besides fossil material from the interior, which had formed part of the collection and working material of Ambrogio Soldani, from whom Fleuriau de Bellevue had received them,[2] and there is little doubt that here we find the first impetus given to the study which was to make the name of Alcide d'Orbigny immortal, when his larger works of geology and travel should have passed from senility into something approaching oblivion. It was natural that, from studying and drawing the forms for his father, he should make collections of his own from the rich store of material lying close at hand on the mud flats of the Anse de l'Aiguillon, and accordingly in 1819 we find the elder d'Orbigny writing to Fleuriau de Bellevue a letter on the subject, which may be said to be the earliest printed document relating to living Foraminifera as they are understood and studied at the present day.[3] The letter of 1819 is the more interesting since from it it would appear that it was d'Orbigny père who was responsible originally for classing the Foraminifera among the Cephalopoda. It must be borne in mind that at this time Alcide d'Orbigny was only seventeen years of age. He had, however, been strongly attracted to natural science from his earliest years, as may be gathered from another, earlier letter in the possession of Madame Henri d'Orbigny (his daughter-in-law), written to him by his father when he was only eleven years old, and which by her permission I have reproduced in Appendix B. In the letter of 1819 his father says:—

"I have just made a discovery of considerable zoological importance, and I hasten to apprize you of it. I think I have already told you that species of microscopic Cephalopods related to those observed in the sands of Rimini were to be found in great numbers in our sands of the Golfe de l'Aiguillon, and of Angoulins[4]: I have already described

[1] XXIII., p. 165.
[2] XX., p. 153; XXI., p. 435.
[3] "Extrait d'une Lettre de M. d'Orbigny, Médécin à Esnandes près La Rochelle, à M. Fleuriau de Bellevue sur la découverte de Cephalopodes microscopiques sur les côtes de l'Océan"—Journal de Physique, de Chimie, d'Histoire Naturelle, et des Arts . . . par M. H. M. Ducrotay de Blainville, lxxxviii., Paris, Jan., 1819, pp. 187–188, Zoologie (Fevrier, 1819).
[4] Angoulins is a small watering-place 6 kils. to the south of La Rochelle, adjoining the Plage de Chatelaillon, whence I have made a point of making a shore gathering, the richness of whose Foraminiferal fauna may be seen on a glance at our list of species from that locality.

more than a hundred species or varieties from these two localities, and my son is occupied drawing them, for I have observed so much in my life that I can hardly see at all, and I am often obliged to borrow his eyes.

"The great number of shells of these mollusca which are found in our sands, led me to presume that the animal lived on our shores, and set me to look for them; the difficulty was to discover such small creatures; their exceeding smallness was a great obstacle; even my son, in spite of his piercing and trained sight, had not yet discovered anything when one day he brought me some Polyzoa (*Polypiers*) which he had just gathered on the rocks at Marsilly[1] at very low tide; we placed them in sea-water with the idea of seeing one of the Polyps develop; my son thought he saw some grains of fine sand which had fallen to the bottom of the bowl, move, we put some of this supposed sand in a watch-glass on a mirror, we watched it and we had the extreme satisfaction of seeing swim in it 'Lenticulines, Rotalies, Discorbes, Spirolines,' etc., whose shell one could perfectly well make out through the animal, which is ornamented with the most lively colours; we saw them moving little arms or tentacles, the number of which we could not count, our magnifyer not enlarging sufficiently. We placed a few fronds of the Polyzoa in the watch-glass and observed them carefully; many of these little animals appeared clinging to the orifices of the chambers (*polypidoms*); were they engaged devouring the Polyps? this is what I presume.

"I have no doubt that if we had had a better instrument I should have been able to observe all parts of these little animals, and to draw them, but what is deferred is not relinquished; they are sufficiently numerous to encourage the hope that I can find them whenever I want them. When you return to La Rochelle I shall ask you to obtain for me the loan of the Microscope of the Cabinet d'Histoire Naturelle; I am so accustomed to using this instrument that I shall soon be in a position to send exact drawings of these different kinds of little animals, which, I think, are not yet known. I have many in alcohol, but they contract in it; I will risk sending some in the case which I am preparing for the Museum, with their drawings.

"If you see nothing against it, you can announce this to M. de Blainville and tell him I count on sending him this spring a notice of these animals, with the drawings of those which I shall have been able to observe."

There are many points of great interest about this letter, to some of which we shall refer later. It proves conclusively, however, that the study of the Foraminifera originated with the elder d'Orbigny, who directed the earlier studies of his son, as the latter fully acknowledges in his "Tableau Méthodique."[2] It throws light also upon the imperfect means of observation at his disposal

[1] Marsilly is a small village on the Anse de l'Aiguillon, which one passes in going from La Rochelle to Esnandes. It has, like Esnandes, a very remarkable fortified church-tower of the Gothic period (restored in 1608).

[2] I., p. 123.

at this period, a difficulty which was later removed by the loan of the Microscope to which I shall have occasion to refer in another place (see p. 10). This instrument was at his service after the migration of the family to La Rochelle, which took place in 1820, as above related.[1] Once established at La Rochelle, the elder Orbigny was more closely associated with Fleuriau de Bellevue, and whilst still practising medicine he devoted himself to a study of the flora and fauna, both zoological and geological, of the district, and it is due to the efforts of these two ardent naturalists that the first local Museum in France, that of La Rochelle, was founded in 1835.[2] He corresponded with naturalists in Paris and elsewhere, furnishing them with local specimens. Latreille, in his Report on the "Tableau Méthodique" (*vide post*, p. 20), takes occasion to say of Alcide, that "he was influenced by the example, the encouragement and the instructions of a father who, not less expert in his profession of Medicine than in Natural History, was entrusted with the organization of the Museum of La Rochelle . . . and who earned by his services the title of Correspondent of the Natural History Museum of Paris, and with whom your Reporting Commissioner has for a long time been in communication on matters relating to the progress of entomology." Both Alcide and his brother Charles accompanied their father in his scientific rambles, and as Fischer has observed, "they thus learned to seek and observe, and their precocious talent as draughtsmen found occasion for its exercise at every step."[3] The elder d'Orbigny died at La Rochelle in 1856, aged eighty-six; his biographer says of him, "Poet, musician, agriculturist, doctor, naturalist, he was in himself a living encyclopædia. If, less anxious to embrace all knowledge, he had specialized more, he would have without doubt gained for himself a still greater celebrity."[4]

Charles d'Orbigny, the younger brother by four years of Alcide, born like him at Coueron (December 12, 1806), became a physician in Paris, where he was a medical student during the cholera epidemic of 1832; but in 1833 he published a "Tableau synoptique du règne végétal appliqué à la medecine," a work almost as ambitious for a youth of twenty-seven, as was his brother's "Tableau Méthodique" for a youth of twenty-three. He became assistant to Cordier, Professor of Geology at the Muséum d'Histoire Naturelle, and published many works that do not concern us. His *magnum opus* was the "Dictionnaire universelle d'Histoire Naturelle" in sixteen volumes, to which all the leading naturalists of the day contributed, and in which Alcide d'Orbigny wrote an important article on the Foraminifera

[1] XXIV., p. 355.
[2] XXI., p. 434; XXIV., p. 355.
[3] XXI., p. 434.
[4] XXII., p. 2.

Plate II. Esnandes: The "bouchots" with a shrimp-catcher.

(v., 1844–5, pp. 662–671, Bibl. XIII.).[1] He became secretary of the Geological Society of France, and joint Professor with Cordier at the Muséum de Paris, and he died in Paris, February 14, 1876, aged seventy.[2] (See Appendix A.)

The years which immediately followed the migration of the family from Esnandes to La Rochelle were pregnant with great issues. Apart from the rich Foraminiferal fauna of the neighbouring shores, and the abundant fossil forms which were at hand in the Upper Jurassic strata of the surrounding country, the mediæval charm and historical associations of the place cannot have been without their influence upon the impressionable mind of an ardent young naturalist. La Rochelle is not an easy place to get to, and the old Huguenot stronghold conveys an impression of not having been very much modernized since the days of religious struggle in the sixteenth century, or of the great Siege of 1627–28. Ruined commercially by the cession of Canada to Great Britain in 1763, it relapsed into old-world desuetude, and one has but to stroll from the Port, with its quaint towers of the fifteenth century, to the wonderful Hotel de Ville of the thirteenth century, between the timbered and arcaded houses of the Rue des Merciers, to realize that he is in a back-water of the stream of life: adown the narrow streets beneath the porticoes, it is not difficult for him to whom historical romance makes appeal, to imagine the Three Musketeers, Athos, Porthos and Aramis, with the irrepressible Artagnan, flaunting their diversified individualities fresh from their exploit at the Bastion St. Gervais, in the brilliant train of the Great Cardinal. Here Réaumur was born in 1683; here was born that grim figure of the Revolution, the Conventionnel Billaud-Varennes, who had died only the year before the d'Orbigny family arrived there; here were born in 1775 Admiral Duperrey, on whose voyage round the world Lesson collected Foraminifera for d'Orbigny (see note 1, p. 13), and in 1773 the botanist Bonpland, who was one of the intimate friends of the family,[3] and

[1] The manner of publication of this work, in "livraisons" extending over a period from 1839 to 1849, has resulted in some confusion in dating the completed volumes. A careful analysis and study of these dates has been made by C. Davies Sherborn, in Ann. Mag. Nat. Hist., ser. 7, iii. (1899) pp. 350–2 (see note 2, p. 58).

[2] Not on the 15th, as has been stated. Charles d'Orbigny the younger died a widower, without children. One of the brothers, Edouard, had five children: (1) Gaston, who died Inspecteur des Enfants assistés. (2) Alcide, who was elected Conseiller municipal in 1874, Conseiller Général du Département de la Charente Inférieure, and Maire of La Rochelle in the years 1895–1905. He was made Knight of the Legion of Honour in 1897, and died at Nice April 9, 1907. (3) A daughter Marie, wife of M. G. Perrier, at La Rochelle. Of the death of the other two sons we have given an account in Appendix A.

[3] In this year also, at La Rochelle, was born Fromentin, and in 1825 (the year of the "Tableau Méthodique") Bouguereau, two of France's greatest painters of all time.

who took part with d'Orbigny père in the foundation of the Museum with Fleuriau de Bellevue in 1835.

Beltremieux, in his short memoir of the family, states that the three naturalists founded the Société des Sciences Naturelles de la Charente Inférieure at the same time;[1] but this is not so, the Society was founded as early as 1732, and was flourishing when the d'Orbigny family settled in the town—as is indicated in the letter we have cited above. The Microscope, "du Cabinet d'Histoire Naturelle,"[2] was placed by Fleuriau de Bellevue at d'Orbigny's disposal, and an instrument formerly the property of Fleuriau de Bellevue, and presented by him to the Museum at La Rochelle, still exists, and is said to be the instrument used by the d'Orbignys. I have had the interesting experience of examining some of d'Orbigny's own material through it, by the courtesy of Dr. Etienne Loppé, curator of the Musée Fleuriau de Bellevue, by whose good offices I have been furnished with the photograph of the instrument which is reproduced on Plate VI, fig. 1. I have, however, submitted this photograph to Mr. T. H. Court and to Dr. Charles Singer, and they are both of opinion that it represents an instrument of later date than 1819. Dr. Singer founds his opinion on the milling of the rims as shown, which is of a type not introduced till later; Mr. Court, on the other hand, argues from perhaps more concrete evidence.[3]

The type-specimens enumerated in the "Tableau Méthodique" are preserved in Paris, but the original collection and mounts of the d'Orbignys, father and son, were stored, in a condition of some dilapidation and neglect, in the Museum at La Rochelle until 1884, when M. Charles Basset, a Member of the Société des Sciences Naturelles, was entrusted with the task of re-organizing them. The material was—and such part of it as yet remains is still—preserved in little stout bottles of very common glass. Each bottle contains one species, probably from mixed localities; many of them are unlabelled, but many are labelled "Madagascar," "Bourbon," "Otahyte," and so on; these latter contain for the

[1] XXIV., p. 355.

[2] See the letter of d'Orbigny père, *ante*.

[3] Mr. Court, in an interesting letter on this photograph, observes: "The Microscope is, in my opinion, of a date later than 1819. It is an improved form of the Ellis Aquatic Microscope, and is known as Raspail's Simple Microscope, and, as far as I am aware, was used by him in 1827 and after in his work on Organic Chemistry, which was published in 1833. I find an illustration of this Microscope, exactly the same as the photograph you send, line for line, in a Catalogue of Optical Instruments issued by Menier, a French optician, in 1851, or, it must be, after, as it prices the apparatus for photography by the collodion process, which was not invented till the year 1851. The price is 35 francs. Although the instrument shown in the photograph appears to me to be of a much later date than 1819, it is very likely that d'Orbigny used such a Microscope in a more simple form in his investigations." Dr. Singer observes that, save for the feature above referred to, there is nothing in the general construction of the instrument to prevent our placing it in 1819.

most part almost pure gatherings of Amphistegina.[1] The original "mounts" of d'Orbigny were merely small oblong slips of coarse brown paper upon which half a dozen specimens of a species were stuck with thick spots of gum. From these, and from the bottles, Basset mounted one hundred and thirty-six slides, which I have carefully examined. Unhappily the modern sunken-cell slide with a removable cover (or without) was not then available in La Rochelle, and Basset having soaked the tests from the papers, or extracted specimens from the bottles, mounted each species on a glass slip in a zinc cell which he covered with a cemented cover-glass, often I am sorry to say before they were dry, so that a great many, indeed nearly all of them, are now merely an indistinguishable mass of mycelium and fungus. Localities are appended to many of the slides, but not by any means to the majority, and these localities were taken apparently haphazard—and in this Dr. Loppé agrees—from the "Tableau Méthodique."[2]

Deplorable, however, as is the condition of this collection, it is of great, if perhaps principally romantic, interest, as being the original collection of d'Orbigny père, from which Alcide d'Orbigny made his first studies for the "Tableau Méthodique" and from which he constructed his famous "Models." The recent specimens are principally from Rimini and from the bottles referred to; the fossils, from the beds of Paris, Valognes, Dax, Bordeaux, and other adjacent strata.[3]

It is evident that d'Orbigny's serious and systematic work on the "Tableau" did not begin until he was settled at La Rochelle. His observations at Esnandes have been already referred to; Carpenter, who errs perhaps on the side of severity in his estimate and criticisms of d'Orbigny's work, remarks, "if his determination of their Molluscous nature was based on any actual observations of these animals in their living state, it is certain that such observations must have been of the most superficial character."[4] We have seen (*ante*) in what those observations consisted, and I cannot find any evidence that Carpenter knew of the letter which I have cited *in extenso*; but Carpenter's view receives some support from the fact that d'Orbigny in the "Tableau" only gives La Rochelle as a locality for two species,[5] whereas Earland and I have identified (*vide post*) no less than 129 species from the

[1] "Ces coquilles microscopiques étaient logées dans des petites bouteilles en verre bulleux et sur des petits morceaux de carton grisâtre qui ne permettaient pas de les voir distinctement" (Basset, XXIII., p. 154).

[2] M. Charles Basset, who is described in the list of members for 1885 as "Négociant. Membre titulaire," died at La Rochelle in January, 1914.

[3] As already noted the types were taken by d'Orbigny to Paris (*vide post*), but, as Basset observes concerning the La Rochelle collection, "of the 52 genera then known, 37 are represented in the collection, and 38 species are taken as types for the plaster models hereinafter referred to" (XXIII., p. 159).

[4] XVII., p 5.

[5] *Polymorphina* (*Globulina*) *gibba* and *sulcata* (I., p. 266, Nos. 20, 21).

mud-flats of Esnandes, and 111 species from the clean shore-sands of Chatelaillon.[1] We may, however, claim for him in this place that already he had set before him the principle which he enunciated in one of his latest works, where he says: "I have never had any other aims in my work than the advancement of science, to which I have consecrated my existence. In reflecting upon the immense labours that this assemblage of facts have cost me, I have only aimed at enabling the whole world to profit by the advantages which I have so painfully conquered at the expense of my vigils."[2]

At La Rochelle the systematic collection of material began in earnest. He corresponded with the leading naturalists of France, and pressed into his service the commanders, doctors, and naturalists of ships plying the oceans of the world in pursuit of commerce or of science, and we find the names of these coadjutors perpetuated in many of his generic and specific names. Thus, whilst still working at La Rochelle we find that he received material, fossiliferous sands from Paris and England, from the Administrators of the Muséum Royal at Paris; from Baron de Férussac,[3] material from the West Indies, the Indian Ocean, and the English coast, and fossils from Bordeaux, Dax, Paris, Champagne and Maestricht; from Fleuriau de Bellevue, recent gatherings from Rimini, Madagascar, and the Cape of Good Hope, fossil from Tours, besides the Soldanian material from Sienna; from Ménard de la Groix, recent material from the Adriatic, fossils from Sienna and other parts of Italy; from Quoy, Gaimard and Gaudichaud, the scientific staff of Captain de Freycinet's voyage round the world,[4] material

[1] Chatelaillon is now a fashionable little watering-place 10 kil. south of La Rochelle, and was the nearest shore-sand from which d'Orbigny could have obtained material after 1820. It is adjacent to the submerged site of a town of that name which was the ancient capital of l'Aunis, which was fortified from the tenth to the fourteenth centuries. The ruins of the old town are still distinguishable at low tide. La Rochelle, which was called Rupella in the tenth century, grew to be the capital of the district after the destruction of Chatelaillon, which commenced in a revolt of its inhabitants against the Dukes of Aquitaine. There is a mussel industry in all respects similar to that of Esnandes, and an oyster fishery to the south of Chatelaillon.

[2] XI., p. 10.

[3] This is a name which we shall encounter frequently in this Memoir. André Etienne Just Pascal Joseph François d'Audebard, Baron de Férussac, born 1786, died 1836. He was the son of a well-known botanist and conchologist, Jean Baptiste Louis d'Audebard de Férussac (born 1745, died 1815), and was what would be called to-day primarily an amateur conchologist. He was a soldier, but left the army after being wounded in the Peninsular War, and became under Bonaparte Sous-prefét of Oleron. This position he lost at the Restoration, but was appointed Sous-prefét of Compiègne during the Hundred Days, at the end of which he resigned the post in favour of his predecessor. He was appointed Lecturer on Geography to the Army Medical Staff in 1818, but shortly afterwards resigned this post to devote the remainder of his life to Conchology. He founded his "Bulletin des Sciences Naturelles et d'Industrie" in 1823. (See Appendix C.)

[4] M. L. de Freycinet, "Voyage autour du Monde . . . exécuté sur l'Uranie et la Physicienne pendant . . . 1817–20." Paris, 1824–30. Zoology by Quoy and Gaimard; Botany by Gaudichaud. (See Sherborn and Woodward, Art. cit., p. 47, note 3.)

from Rawack, Port Jackson, the Admiralty (Seychelles), Marianne, Malouines, and Sandwich Islands, Mauritius and elsewhere; from Lesson and Garnaud (*sic* ? Garnot, see note 1, p. 52), naturalists on board Admiral Duperrey's voyage round the world,[1] material from Rawack,[2] the Malouines,[3] Mauritius, and the Cape of Good Hope; from Brongniart, fossil material from Castel Arquato and the Paris Basin; from Defrance, recent material from the Red Sea, fossil from Orglandes and Valognes; from Leclerc-Thouin, recent material from the Mediterranean, fossil from Paris, Montolieux and Chavagnes; from Rang, material from the Mediterranean; from Dufresne, fossil material from Paris and England; from Grateloup of Bordeaux, the fossil material from Dax; from Boué, fossil material from Dax, Bordeaux, and Paris; from Guerin (see p. 14, note 2), various samples; and from Gerville, the fossils of Valognes, Orglandes, and other localities in the department of Calvados. One has only to glance through the pages of the "Tableau Méthodique" to see what use he made of each and all of these contributions to his work (see p. 29).

The bulk of this remarkable collection he took to Paris with him in 1824, where it is still preserved. But, alas! as we have had occasion to record elsewhere, the original bottles and tubes containing d'Orbigny's material were stored in the cellars of the Musée de Paléontologie; these cellars were flooded by the rising of the Seine in 1912, and many of the labels were washed off and lost.[4] Fortunately, however, when Schlumberger went over the collection he put labels *inside* many of the bottles (a lesson to all collectors), and we owe it to him that the loss to science was not greater than it is.

II.—The Models.

The first tangible result of d'Orbigny's work at La Rochelle was the construction and issue of his celebrated "Models." Students of the group who have sometimes a tendency to regard these Models with something like tolerant pity must not lose sight of the fact that Daguerre was at that time only groping, literally in the dark, after the effects of light upon iodide of silver, and that microphotography was undreamed of. I have often wondered when looking at the early daguerreotype of d'Orbigny

[1] L. J. Duperrey, "Voyage autour du Monde . . . sur . . . la Coquille pendant . . . 1822-25," Paris, 1826–1834. (See Sherborn and Woodward, Art. cit., p. 47, note 3.)

[2] The Ile de Rawack is known in British Admiralty Charts as Lawak Island; it lies off the N.W. coast of New Guinea in 0′ 1′ 20″ S., and 131′ 1′ 30″ E.

[3] Now known as the Falkland Islands, off the S.E. coast of South America.

[4] XXVII., p. 544.

which I reproduce in Plate VII what must have been the reflections of the sitter—whether it ever occurred to him that he was face to face with an agency which was destined to revolutionize the study of microscopic life. His own account of the matter in 1825 was as follows:[1] "With a view to giving greater publicity to the work I had undertaken, and with the object of making it available to everybody without entailing the necessity of observing the numerous genera of Foraminifera under the Microscope, I have had the idea of sculpting a shell of each genus and each sub-genus of this order about 1 in. (Fr.) in size; from these I have made matrices by means of which we can have many specimens of each shell, and, in accordance with a desire expressed by many persons to have this collection, I have determined to issue it by instalments; two of these instalments have appeared for some time and the two remaining ones are on the point of publication: the four constitute a collection of 100 models which comprise all the genera and sub-genera, and even the principal species of the order of the Foraminifera."

The first instalment—Models Nos. 1 to 25—was ready and was delivered early in 1823. The labels for all four instalments, which were delivered in sets of twenty-five, were all printed at once, so that the label of the fourth is identical with that of the first, excepting for the number of the instalment.[2] The label, of which a translation has been published by Messrs. Parker and Jones,[3] is not uninstructive; it reads: "Models / of / Microscopic Cephalopods, / living and fossil / representing one individual only of each of the principal divisions of a / new Method based on the plan of growth of the shells./ The diameter of these Models has been enlarged to from 40 to 200 times that of the original shells in order to / make all their characters more recognizable. / By M. Alcide Dessalines d'Orbigny Fils. / The Subscription will entitle to four instalments, each of which will comprise 25 Models, and in addition 3 to / 4 shells, for the first 60 subscribers: the extreme rarity of the originals does not justify / the promise of more at the present time. (They are here enclosed in glass boxes which must only be opened / with the greatest precaution.) / The four instalments will be sent out during the course of the first 6 months of the year 1823; the price of / each one is 20 francs, and will be payable either at La Rochelle, to the Author (Jardin des Capucins) or / in Paris to M. . . . ., by prepaid letters with

[1] I., pp. 247–8. See also I., p. 98.

[2] A footnote in I., p. 99, tells us:—"The work consists of four instalments. Each instalment consists of twenty-five models contained in a box with compartments, and is sold at 20 fr. The dépot is established at Paris, at M. Guérin, rue des Fossés-Saint-Victor, No. 14." This M. Guérin was one of the persons who had supplied him with "des sables des diverses localités" (I., p. 250), and he was probably a trader in objects of natural history and scientific appliances.

[3] XIX., p. 16.

the money enclosed. / The first instalment of these Models may be seen in Paris, at the Museum d'Histoire Naturelle du Jardin du / Roi, and at M.M. . . . . . / The Subscribers will receive with the fourth instalment the 'Tableau méthodique' of the distribution of these Cepha / lopods, which will indicate by numbers corresponding with those of the Models the name of the individuals sent / and the order of their classification. / 1st (2nd, 3rd, or 4th) Instalment. / Nota. The coloured Models represent the fossil shells, and the white ones the living. The position and the form / of the Syphons are indicated upon them by black lines or spots."

We learn from this label that the whole plan or catalogue of the four instalments was settled as early as 1823, that d'Orbigny was already in correspondence with Baron de Férussac at the Muséum de l'Histoire Naturelle, and that the title of his work was already determined upon; but there is no indication at this date that the "Tableau Méthodique" was to be merely the "Prodrome" of a larger work (*vide post*, p. 19). His use of the word "Syphons" would seem to denote that he had not at this date separated the Foraminifera (Asiphonifères) from the Siphonifères. He tells us [1] that he issued the first instalment at the end of four years of work (which gives us, as above related, the year 1819 for the commencement of his studies), and that from that moment he "devoted himself more particularly to the study of the relationships on which to found their classification, regard being had to the work of previous workers on the same subject." The fact that the third and fourth instalments are fully accounted for in the "Tableau Méthodique" proves that they were ready for issue when his work was read before the Académie des Sciences (November 7, 1825); therefore, as Parker and Jones properly observe: [2] "the Models having been published in 1823, the type-forms represented by them take precedence of identical forms subsequently published in the 'Tableau Méthodique' or elsewhere." (See Appendix C.) This, however, applies, *sensu restricto*, to the first and second instalments only.

The original Models cut by the hand of d'Orbigny, from which the matrices were made for multiplying them, are in the cabinet of the Director of the Musée de Paléontologie in Paris. They are apparently cut in a brown gypsum, and are still covered with traces of the white plaster used for making the moulds. They were presented to the Museum about the year 1894 by his son Henri d'Orbigny, who was an entomologist, and who died in Paris in 1915. (See Appendix A.)

The boxes in which the Models were sent out were divided into thirty compartments, twenty-five occupied by the Models,

[1] I., p. 124. [2] XVIII., p. 430.

and the remaining five by the "3 à 4 coquilles en outre" referred to on the label. These are not in "glass boxes" in the set preserved as it was received by La Rochelle, but are the coarse brown paper slips above referred to, on which are heavily gummed a few of the actual shells, generally of the larger and more robust forms, represented by Models in the particular instalment.[1]

As promised on the label, with the fourth instalment, in 1826, each subscriber received a pamphlet of 150 pages, entitled[2] "Tableau Méthodique de la Classe des Céphalopodes par M. Dessalines d'Orbigny (Extrait des Annales des Sciences Naturelles, etc.)," Paris, Chez Crochard, Cloître St. Benoit, No. 16, 1826. The plates are sometimes folded to the size of the pamphlet, and at page 148 commences a list headed "Explication des Modèles."[3]

Messrs. Parker and Jones in the year 1865 made a most elaborate and painstaking study of these Models, discussing the identities of each one in turn and giving excellent outline representations of them (see Bibl. XIX.). To this they appended a Table, in which d'Orbigny's original name is given, and, in juxtaposition, corrected names, showing where d'Orbigny's nomenclature required to be altered after reference to other authorities.[4]

There remains to be mentioned a mysterious "Fifth instalment," which is mentioned frequently in the four monographs published by d'Orbigny in 1839–40, and in the Vienna monograph of 1846. It is first announced in the Cuba monograph, and thereafter as if it had been issued, but in spite of diligent inquiry I have not been able to trace the existence of any of these later Models, but it was evidently his intention to include in this instalment Models of typical species instituted by him in those later works. I have noted fifteen Models thus referred to, of which a list will be found with the requisite references in Appendix D.

[1] I possess, by the courtesy of the Administration of the Musée Fleuriau de Bellevue, two or three of these brown paper mounts, and a few samples of the material from the bottles of d'Orbigny père.

[2] This title is taken from a copy preserved in the Department of Conchology at the British Museum (Natural History). (See, however, Appendix C.)

[3] The Models were all recast and re-issued as a second edition *en bloc* in 1843. In the pamphlet accompanying them the whole of d'Orbigny's original introduction is suppressed, and it consists of merely a short introductory paragraph followed by the list from p. 148 of the original pamphlet (24 pp.). The title is :— "Modèles de Foraminifères vivans et fossiles, par Alcide d'Orbigny. Deuxième edition. Paris, 1843. Cosson." It will be remembered that Félix Dujardin had "happened" since the first issue.

[4] They also append a list and description of the Models issued in 1861–5 by Reuss and Fritsch with a view to supplementing or completing the d'Orbigny Models. These Models have not received extended recognition among Rhizopodists.

Plate III. Esnandes: The "acons" of the mussel fishers.

III.—d'Orbigny's Generic and Specific Names.

The student of the Foraminifera whose reasonable curiosity—for it frequently must amount to no more than that—prompts him to endeavour to identify the d'Orbignyan species, can hardly fail to be appalled by the riotous profusion of his specific names, many of them *nomina nuda*, now fortunately to a great extent absorbed into the synonymies of later-named species. It is far from uninteresting, however, to examine into the circumstances which led to this wild orgy of nomenclature, especially having regard to the fact that on more than one occasion he severely reproved the multiplication of names regardless of existing nomenclatures.[1]

It must be borne in mind that one of the foundations of his scientific creed was that the successive "animalization" of the terrestrial sphere resulted from twenty-six distinct creations, and that "when he found two fossil shells in two different strata he often separated them into two different species without sufficient motive."[2] He says himself, "If I find in Nature forms which after the most scrupulous analysis present no appreciable difference, though they are separated by an interval of a few strata . . . I should not hesitate for an instant in regarding them as distinct."[3] But he carried it even further than this. He was so convinced that widely separated localities, e.g. the West Indies and the Mediterranean, were characterized by entirely different fauna that he had no scruple in giving to the same shell two different names for no other reason than that they came from such widely separated regions. It is thus that in the various monographs of d'Orbigny almost every species is described as new, with a new specific name.[4] It is hardly surprising, therefore, that the supply of specific names was sometimes hardly equal to the demand. His biographer Gaudry points out that "when anyone sent him new species it was his custom to dedicate one of them to him. People were glad to see their names perpetuated by that of one of

[1] Thus in the Vienna monograph (XII., p. 143) he condemns Bosc for making two new species of Alveolites (C. Bosc, "Sur deux nouvelles Alveolites." Bull. Séances Soc. Philomathique, No. 61, iii. (Paris, 1811) p. 99). He says that "unfortunately at this period, little recking of the works of their predecessors, and particularly of names already given, the authors, as if wantonly, confused matters by giving new names."

[2] XVI., p. 836.

[3] XV., p. xxxviii. He goes on to say that in such cases "we must assume that it is our methods of distinction which are insufficient for finding the differences between these two species, from widely-separated epochs, which resemble one another."

[4] There are scores of such instances: to name only one, having found *Cristellaria* (*Robulina*) *calcar* (I., p. 289, No. 12) in the Vienna material, he re-named it *Robulina echinata* (XII., p. 100).

Nature's products, and there was mingled with this feeling of innocent vanity the noble desire to contribute to the progress of science."[1] In referring to the services rendered to science by workers who thus contributed to his collections d'Orbigny observes somewhat naïvely: "It is on this account that I have with pleasure introduced into science, as an ineffaceable testimony of my gratitude, the names of many modest scientists whose persevering and indefatigable researches have so powerfully contributed to guaranteeing the results of my own."[2]

He changed his own names for remarkably insufficient reasons, witness his *Cristellaria* (*Robulina*) *cultrata* from the Adriatic,[3] which became *canariensis* from the Canary Islands,[4] and *subcultrata* from South America, it being stated in a footnote that the name "had to be changed because he had found the species in Patagonia"; and also his *Pulvinulina* (*Rotalina*) *truncatulinoides* from the Canaries,[5] which became *micheliniana* from the Paris chalk[6] (see, however, the note on the Paris Chalk Memoir, p. 54). In the Cuba Memoir, on the same principle, he changed the name of *Planorbulina mediterranensis* to *P. vulgaris* on the ground that the species was to be found elsewhere than in the Mediterranean.[7]

From what has preceded it will be readily appreciated that the curious inquirer into d'Orbignyan nomenclature is apt to find himself hopelessly lost, but the inquiry may almost be described as a hobby by itself, and it is far from uninteresting to follow the advice of Captain Cuttle when opportunity serves for the identification of these persons, apart from the genera and species to which d'Orbigny gave their names. I plead guilty to having indulged in this desultory amusement, and I have embodied a selection of my notes made over an extended period in Appendix E. Latreille, in his "Rapport" upon the "Tableau Méthodique," expresses the regret (p. 25) that d'Orbigny did not add "a Linnean phrase to his trivial and specific names," but he rightly observes that the indications which these would have furnished were reserved for d'Orbigny's "grand ouvrage"—which never saw the light, save as is hereinafter set forth.[8]

[1] XVI., p. 831.

[2] XV., p. lvii. In his "Mollusques vivants et fossiles" he says, "Je citerai toujours avec le plus grand soin les personnes auxquelles je devrai les moindres communications, afin de faire connaître leur collaboration" (XI., p. 12).

[3] I., p. 287, No. 1. [4] VIII., p. 127. [5] VIII., p. 132.

[6] X., p. 31. This being a common form of world-wide distribution, the confusion is a serious one, but the two names are now understood by all Rhizopodists to be interchangeable, *micheliniana* having been very universally used for many years, and by Brady in the 'Challenger' Monograph (see Brady, op. cit., p. 695, and XXVI. (1909) p. 685). [7] VII., p. 85 (note).

[8] He adds prophetically that "circumstances seem to adjourn the execution of this work to a far distant time," announcing the appointment of d'Orbigny to the post of naturaliste-voyageur to the museum and his impending departure for South America.

IV.—The "Tableau Méthodique de la Classe des Céphalopodes."

It is a matter of great interest and importance to note, as one cannot help doing as he peruses not only the "Tableau Méthodique," but also d'Orbigny's later works and the observations made upon them by his contemporaries, how it came about that this young naturalist of twenty-three years of age came to publish a work which was admittedly incomplete, which was, as he himself repeatedly emphasized, merely the "Prodrome" of a larger work destined never to be completed, but which has nevertheless remained the foundation of the modern study of the Foraminifera.

That the "Tableau Méthodique" was no more than a preliminary publication is made clear by his own statements contained therein and in his later works. He alludes to it as a "Prodrome" in a note to the original title, and elsewhere in the "Tableau."[1] In the Cuba Memoir he first published diagnoses of his genera, not only of those appearing in that work, and in the "Tableau," but of all which were known to him at that time. He says: "I give here a *Genera* and a *résumé* of the general observations which I propose to publish later in a special work on the Foraminifera, both recent and fossil, upon which I have been occupied for many years,"[2] and in the same work, referring to Deshayes' "Mémoire sur les Alveolines,"[3] in which five of his species with their synonymies are given, saying that Deshayes had elaborated what he had only been able to give "in an abbreviated form such as was rendered necessary by the limits which I was obliged to set to my 'Tableau,' not being able then to publish my general work on the Foraminifera."[4] In his Memoir on the Cretaceous Foraminifera of the Paris Basin he adds: "Unfortunately my departure for America prevented my publishing the entire work, and Prodrome alone appeared."[5] De Férussac, in his Introduction to the "Tableau," speaks of "the great work already in an advanced state which he is preparing upon these little shells," and says that he has already completed nearly half of the plates for this great work. It would appear that de Férussac's original intention was that the complete work should form part of the "Suite des Monographies de toutes les classes des Céphalopodes," which he had in contemplation.[6] D'Orbigny in the "Tableau" tells us that "the history of the Nummulites is too confused for me to give here a complete list

[1] I., pp. 96, 121, 132.
[2] VII., p. xii.
[3] Ann. Sci. Nat., xiv. (1828), pp. 225–236.
[4] VII., p. 70.
[5] X., p. 2.
[6] I., pp. 118, 119, *120*, 121.

of species," and he reserves further comment "for the general work."[1]

What, then, is the explanation of this preliminary publication? We may gather it from d'Orbigny's later works, and from the "Rapport" upon the "Tableau Méthodique" made by Latreille,[2] in which, though it was made after the presentation of the "Prodrome," the work of d'Orbigny is described as "unpublished." D'Orbigny tells us, in his Introduction to de Férussac's mainly posthumous work on the "Céphalopodes Acetabulifères,"[3] that Fleuriau de Bellevue took the drawings he had made of Mollusca, Radiata, and Cephalopoda (i.e. Foraminifera) to Paris with him in 1822, and showed them to Cuvier, Brongniart, de Férussac, and other scientists, and this would appear to have constituted his first introduction to de Férussac.[4] We have seen that d'Orbigny was in correspondence with him in 1823. (See Appendix C, p. 90.) Now, de Férussac had published in 1822 a work in which he had dealt with the hitherto noted species of Foraminifera among the Cephalopod Mollusca,[5] and further confusion had been introduced in the same year by Lamarck in the seventh volume of his "Animaux sans Vertèbres."[6] De Férussac tells us, in his Introduction to the "Tableau," that as he knew in 1822 that d'Orbigny

[1] I., p. 295 (note). In the last writings of d'Orbigny on the Foraminifera he still referred to the Tableau as "le prodrome d'un ouvrage général sur ces êtres" (XIII., p. 663).

[2] "Rapport fait à l'Académie des Sciences de Paris (Séance du 7e Decembre, 1825), au nom d'une commission composée de MM. Geoffroy-St. Hilaire et Latreille sur un ouvrage inédite de M. A. Dessalines d'Orbigny, ayant pour titre Tableau Méthodique de la Classe des Céphalopodes. M. Latreille, Rapporteur." Paris, Imprimérie de Mme. Veuve Agasse, Rue des Poitevins, No. 6. 1825, i and 27 pp. (reprint).

[3] See note 1 on p. 42.

[4] He repeats in this place that he was only enabled to publish a "Prodrome," but that he has now published in Ramon de la Sagra's work on Cuba "a complete work in which I have established my general views." He also refers to the Canary Islands, South American, and Paris Chalk papers, which dates this Introduction as being written soon after 1840.

[5] "Tableaux systématiques des Animaux mollusques, classés en Familles naturelles dans lesquels on a établi la concordance de tous les systèmes suivi d'un Prodrome Général pour tous les Mollusques terrestres et fluviatiles vivants ou fossiles" (Paris and London, n.d. 1822) (*vide* Sherborn). My copy bears a contemporary MS. date 1821, which is probably correct. In this work, which is of importance to us as being in one sense responsible for the publication of the "Tableau Méthodique" in 1826, the Foraminifera are tabulated (p. xviii) as follows:—

Orthocères (Nodosaire).
Lituites (Canope, Lituole, Spiroline, Spirule).
Discorbes (Cristellaire, Discorbe, Rotalie).
Nautiles (Lenticuline, Nautile).
Camerines (Siderolite, Nummule, Orbiculine, Mélonie).
Milioles (Rimuline, Miliole, Globulite, Anthuse).

These are all included in the first Order (Decapodes) of Class I. (Céphalopodes).

[6] J. P. B. A. de M. de Lamarck, "Histoire naturelle des Animaux sans Vertèbres," ii. (Paris, 1816), pp. 193–197; vii. (Paris, 1822), pp. 580–632. 2nd ed., Paris, 1835–45, 11 vol.

was at work upon the group, he had only attempted to "fill a gap," which had always been an obstacle to systematic work on the Cephalopoda.[1] His conclusions had been erroneous, as he himself recognizes. The enthusiastic labours of d'Orbigny seemed to him to afford an opportunity to correct and explain whilst minimising his errors, and accordingly we learn from d'Orbigny that "M. de Férussac in order that he might have an opportunity of revising his own work earnestly begged me to allow him to present my work to the Académie des Sciences, and he preceded it by a critical Introduction on the methods of classification which had been established before me, an Introduction in which he entirely accepted my views."[2] It may be observed that at this time (1839) d'Orbigny was a good deal annoyed with de Férussac (see *post*, p. 42). Labonnefon observes that "the high opinion that de Férussac had formed of Alcide d'Orbigny caused him to invite him to collaborate in various works which he had in view, a collaboration which was most useful by reason of the observations, and perhaps more so by reason of the drawings, which had been made by the young naturalist";[3] and Latreille remarks that "Baron de Férussac had called d'Orbigny to him, in order that he might be helped by him (d'Orbigny) in his works, to facilitate the publication of those which were the special domain of our young naturalist and thus to contribute to his advancement."[4] He tells us himself,[5] "M. de Férussac caused me to come to Paris at the commencement of 1824. . . . Being kindly received by the scientists of our capital I was enabled to follow my favourite pursuits in an especial manner, and to study under their direction a science which became ever more and more dear to me." We learn from de Férussac that within seven months after his arrival he had completed the "Tableau Méthodique," and finished the plates to the point at which they are practically left at the present day.[6] Latreille considered that de Férussac had taken an unfair advantage of the opportunity thus afforded to him to criticize his opponents and to make a stalking-horse of young d'Orbigny, and he devotes several pages of his Report (pp. 9–13) to emphasizing this opinion, pages for which he takes occasion to remark he is solely responsible, exonerating his fellow-Commissioner, Geoffroy-St. Hilaire, who might have appended a "minority report." Latreille remarks that "M. de Férussac, in giving you his historical summary, would appear to have sought to place himself in the

[1] I., p. 104.
[2] VII., p. xxii.
[3] XXII., p. 3.
[4] Latreille, "Rapport," p. 5.
[5] "Voyage dans l'Amérique Méridionale," i. (1834), p. 3. See also his Introduction to de Férussac's "Céphalopodes Acetabulifères" already quoted (see note 1, p. 42).
[6] He says, "hardly seven months have passed since his arrival in Paris, and M. d'Orbigny has placed himself in a position to publish his Prodrome, and he has finished nearly half the plates for his great work." (I., p. 119.) These are the seventy odd finished "Planches" referred to *infra*.

position of your Reporters, to anticipate their judgment, and in a word to spare them the trouble of drawing up a Report. Enlightened by the observations of M. d'Orbigny it has been easy for him to recognize and appreciate the errors into which he (and others) had fallen. He has thus been enabled to arm himself with criticism, and use it more or less severely against his rivals, to anticipate the criticisms with which he himself might be attacked, to try to parry the blows which might be directed against him, and to present his own method under the most favourable aspect." He does not spare de Férussac, who had attacked his own work "Familles naturelles du règne animal," in consequence of which Geoffroy-St. Hilaire had formally and persistently refused to accept responsibility for these strictures.[1] He asks to be allowed to reply to de Férussac, "it being understood that M. Geoffroy-St. Hilaire incurs no responsibility in this matter." Latreille repeats the dictum of de Férussac that "the Order of the Foraminifera . . . is a creation of M. d'Orbigny."[2] I cannot avoid the reflection that in all branches of Science and Art instances are not lacking in which the work of a young and comparatively unknown worker has been highly extolled, not so much perhaps as a tribute to its intrinsic merit, as to serve as an opportunity of minimizing the work of already eminent and more established labourers in the same field. Latreille points out that seventy-three plates accompany the work; we shall see (p. 36) that this is roughly speaking the number of the completed "Planches inédites" as they remain to-day, and he adds that d'Orbigny's work should have been published as a Mémoir of the Académie des Sciences, if the author, in order to hasten its publication, had not given it to the Annales des Sciences Naturelles.[3]

That the publication was hurried is clear from the circumstances in which it appeared. D'Orbigny left France for South America on July 29, 1826, when the preparations for his journey

[1] He adds, "Although forced to be both judge and party, as often occurs to us in correlative work, I shall endeavour always to comport myself according to these rules, viz., the abnegation of all personal interest, impartial deference to justice, honour and respect for the scientific body of which it is my glory to be a member." This portion of the "Rapport" is a remarkably able piece of argument and special pleading.

[2] Latreille of course had the published "Tableau" before him, it having been presented a month previously.

[3] Latreille is of course merely writing a review of the work, but it is unfortunate that he lends his authority to some of d'Orbigny's sensational errors. For instance, he says that the Foraminifera devour Polyzoa. This is clearly an echo from Charles d'Orbigny's letter of 1819 (see p. 7), in which he suggests that the Foraminifera clinging to the orifices of the polypidoms of the Polyzoa they were examining were devouring them. He takes it, too, on trust from d'Orbigny that the shores of France were poorly provided with Foraminifera as compared with the Adriatic. But he calls attention to the anticipation by d'Orbigny of Ehrenberg's observations upon the profusion of Foraminifera in the Chalk and the Jurassic calcareous beds.

had already been in progress for several months.[1] He had received the appointment, as we shall see later (p. 48), in November, 1825, and, as I have already said, he was described in December as "Naturaliste-voyageur du Muséum d'Histoire Naturelle." De Férussac speaks, in introducing his "Corrections" to the "Tableau" in 1827 (see p. 29), of "the precipitation with which he had to publish his work at the moment when he was embarking for the great voyage which he is at this moment engaged upon in South America."

The "Tableau Méthodique" was presented to the Académie des Sciences on November 7, 1825, and this is the date which d'Orbigny always assigned to the species named therein.[2] We may usefully glance over de Férussac's "Introduction" which has aroused so much controversy. After referring to the uncertainty which existed as to the nature of these organisms, and their internal structure, he points out that d'Orbigny had made out that in many instances the shell was internal, "entirely enclosed in the body or 'sac' of the cephalopod, or entirely covered by a membrane or tunic, and that the animal was furnished with a great number of arms like those of *Nautilus pompilioides*" (p. 100). He records that some forms are of free habit, whilst others are sessile, and argues from this that the sessile forms cannot possess sexual organs, and that they reproduce themselves without conjugation, or even egg-fertilization.[3] He points out that d'Orbigny had reduced the sixty-nine genera already known to twenty-two, but that he had added thirty-one new genera which he had himself discovered, and that before him only Lamarck and Defrance had added a few new genera by direct observation of the animals (p. 104). He calls attention to the reorganization of the classifications of de Blainville and Haan, and to the separation and retention of the Miliolidæ as a genus of Foraminifera, removing them from their place among the Siphonifères. He says that as the work progressed it became apparent that the "Tableau" must include the whole of the Cephalopoda, and not only the Foraminifera as had been the original intention, "in order to direct the attention of naturalists to the families which are most in need of study" (p. 115). He says rightly that the work of d'Orbigny had resulted in the demolition of the whole substructure which had been instituted before him with the figures of de Montfort and the originals he had adopted. He states that he has "carefully verified all d'Orbigny's observations, and recognized by microscopical examination the differences

[1] XXII., p. 5; XVI., p. 817. Fischer says that he started on June 21 (XXI., p. 437).

[2] XV., *passim*. See *post* pp. 61 and 65, note 1.

[3] Both de Férussac and d'Orbigny seemed to regard attached and free Foraminifera as zoologically distinct (I., pp. 101 and 245).

observable in these shells and the correctness of the characters upon which the classification of d'Orbigny is founded" (p. 119). He calls attention to the fact that the scope of d'Orbigny's work is not merely the establishment of a new genus of Cephalopoda, nor the discovery of "a few new species established upon insignificant differences, such as are proposed every day, so great appears to certain minds the glory of attributing new names; it is the establishment of a new Order . . . which is freed from the chaos in which it was plunged," and that here we have thirty-five (*sic*) new genera and nearly 300 species newly discovered and established after a comparative examination of all the others (pp. 119–120).

So much for de Férussac. D'Orbigny himself, in his own Introductory pages to the section devoted to the Siphonifères and larger Cephalopoda (p. 121), points out that his projected work, "of which I present to-day the Prodrome," will comprise the detailed description and drawings from several aspects of over 600 microscopic Cephalopoda, the results of six years' assiduous study. He relates his early difficulties with the microscopic forms, and how they were confused and confounded with the larger species; he relates the obstacles he had to encounter, and "the optical illusions which deceived him as to the real structure of the objects which he had under observation." Sometimes, he says, he examined the same species twenty times before he could conceive how the tiny body managed to grow and retain the same form throughout its life-stages, and he pays a warm tribute to the assistance and encouragement of his father, of Fleuriau de Bellevue (see *ante*, p. 8), and of de Férussac, under whose guidance, and with whose help, he had revised and finished his work (pp. 123–4).

We need not pause to consider the conclusions to which he arrived for the rearrangement of the existing classifications. At this point he gives the first of those four "Tables," which are features of his works, the parts of which dealing with Foraminifera I have reproduced and compared in Appendix F. The outcome of his labours was to relegate all polythalamous Cephalopoda to a second Order, those furnished with a siphon, which he calls *Siphonifères* (*Siphonoïdes* of Haan), and a third Order (*Foraminifères*) comprising "the Polythalamia without any open chamber, in which the last chamber which terminates the shell may even be convex, and which have no siphon, having instead of it merely one or more little apertures which serve for communication between the chambers themselves" (p. 131). He then enumerates very correctly the fundamental differences, even to the texture and material of the shells, which distinguish the Foraminifera from the larger Cephalopoda.

These differences were so fully appreciated by d'Orbigny, and his observations upon them were so exact, that the diagnosis he gives in the introductory pages to his Third Order (p. 245) is

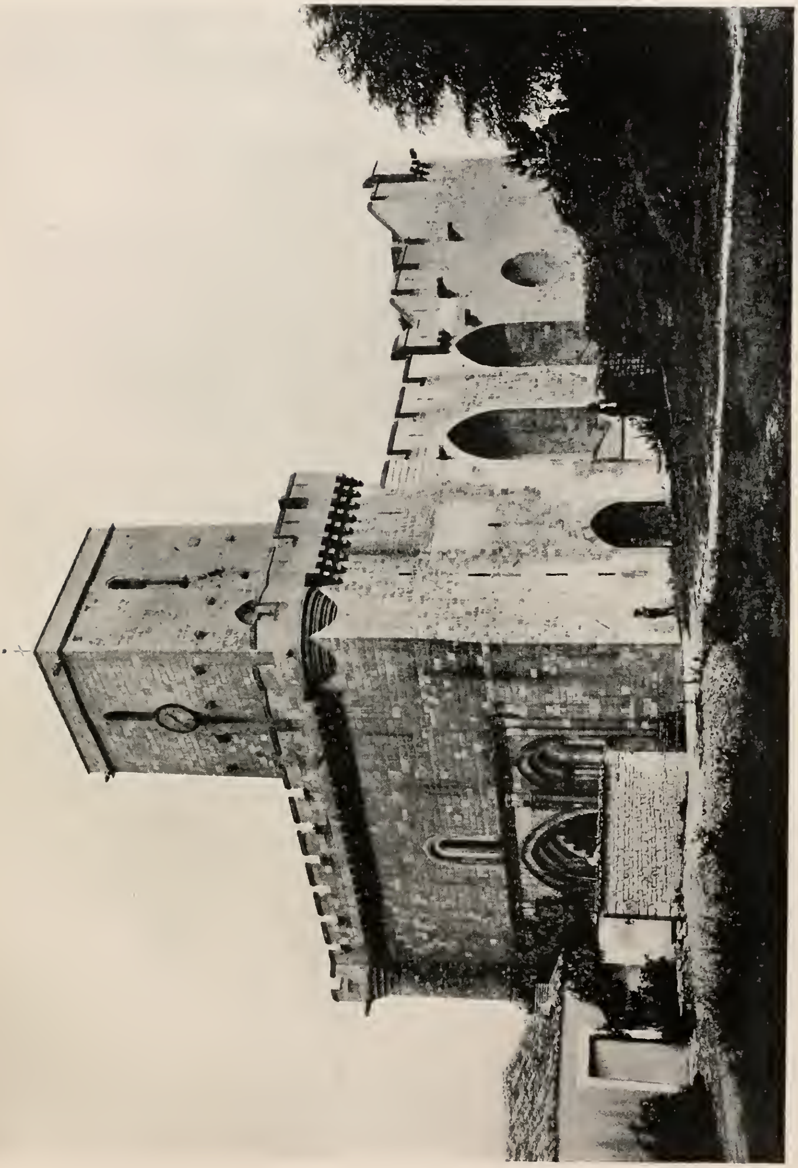


Plate IV. Esnandes : The fortified Church.

absolutely staggering. It is as follows: "The Cephalopoda of this Order have a bursiform body, in the posterior portion of which the shell is enclosed; this body is sometimes of great volume compared with that of the head, to which it serves as a refuge in moments of danger, enclosing it almost entirely in the anterior folds of the skin. This head is very small, slightly, or not at all, distinct from the body, and terminated by numerous tentacles, which are disposed in several rows round the mouth, which is central." At such a description of a Foraminifer as this the brain of the modern Rhizopodist reels, and his senses gape!

He then calls attention to the fact that certain species are sessile or attached, in which case the shell is separated from its host by "a portion of the 'sac' which is interposed between the shell and the foreign body which serves it as a support. This privation of locomotion leads us to presume that in these Mollusca the two sexes are combined in the same individual."

It seemed to d'Orbigny that the attachment of the body to the shell was slight, that when it is touched after death it separates from it, decomposing rapidly, leaving only in the shell a coloured liquor which fills all the cavities of the chambers, the colour-density increasing from the first to the last chamber. D'Orbigny clearly gathered this from the vast masses of *Nonionina depressula* (F. & M.), which compose 99·9 p.c. of the Foraminifera of Esnandes. A large proportion of these shells, which are extremely hyaline, are found, in the dried material, to be full of dark orange protoplasm, and I observed on the spot that whole patches of the mud-surface were coloured orange by the masses of living specimens of the species, a phenomenon which has also been recorded from the mud of the Dee Estuary by the late J. D. Siddall.[1] D'Orbigny goes on to point out that the animals are not tough, but decompose immediately after death, "which is brought about by the least change in their habitual condition, and which makes them very difficult to observe" (p. 246). This is not the case. On the contrary, we have had occasion to remark how tenacious of life these organisms really are. They can be kept for an indefinite length of time in tanks of all sizes, and can be made to flourish in artificial sea-water, and in sea-water modified in various ways for purposes of experiment.[2] D'Orbigny observes further that they are greedy eaters of Polyzoa,[3] that they exist in myriads on all

[1] J. D. Siddall, "Report on the Foraminifera of the Liverpool Marine Biology Committee," Proc. Liverpool Lit. and Phil. Soc., xl., Appendix, p. 45. See also "The Foraminifera of the River Dee," Ann. Mag. Nat. Hist., ser. 4, xvii. (1876) p. 40. Schlumberger has dealt with this question of coloration of the protoplasm in the Feuille des Jeunes Naturalistes, 1882, No. 136, p. 42.

[2] See the observations of Dujardin, *post*, p. 40.

[3] See the letter of d'Orbigny père, *ante*, p. 7.

sea-coasts, but that the European coasts are poor in species and that they are very small, the sole exception being the Adriatic Sea, where the species are more varied, and of greater size. The inaccuracy of this observation is made clear below (see pp. 32, 44, 52, 56). He then goes into the question of the geological distribution of the fossil forms, showing that he had paid far more attention to these than to the living forms which swarm upon the shores adjacent to La Rochelle. He observes (p. 247) that until now only 100 species at most were well known,[1] adding, "we have greatly augmented the number, since I present (in this work) between six and seven hundred very distinct species." He was much interested in their methods of growth, on the plans of which he erroneously founded his six Families, which I may as well set out once and for all in this place.[2]

I. Monostègues (μόνος, *single*; στέγη, *chamber*).
II. Stichostègues (στίχος, *row*).
III. Hélicostègues (ἕλιξ, *spiral*).
IV. Entomostègues (ἔντομος, *cut up*).
V. Enallostègues (ἔναλλος, *alternating*).
VI. Agathistègues (ἀγαθὶς, *a ball of thread*).

The First Family Monostègues made its first appearance in the Cuba Memoir. In 1852, in the "Cours Elémentaire" (Bibl. XIV.) he added a new Family, called Cyclostègues (κύκλὸς, circle), for which see Appendix F. (note 31).

This classification was merely a system based upon the superficial appearances of the shells, and was not destined to outlive its author, excepting for purposes of taxonomy, though, as Fischer observed in 1878,[3] some systematists adhered to it still. As soon as the internal structure of the tests came to be studied the whole edifice fell to the ground. To this matter I shall return later on, when dealing with Carpenter's criticisms of d'Orbigny and his system.

Such, then, are the circumstances and conclusions which led up to the "Tableau Méthodique," to the contents and composition of which we may now address ourselves.

D'Orbigny's estimate of the number of species described in the

[1] It will be remembered that d'Orbigny père wrote to Fleuriau de Bellevue that his son was engaged (in 1819) in drawing "over a hundred species and varieties from the Anse de l'Aiguillon and Angoulins."

[2] He noted the presence of a primordial chamber in all cases (he had not yet recognized or included any monothalamous forms—see p. 52), and the manner in which the succeeding chambers become added to it, always an entire chamber at a time, and remarks, "Often the added chamber is as large in itself as the whole of the rest of the shell, a circumstance which must occasion very great displacements in certain parts of the animal" (I., p. 247).

[3] XXI., pp. 435–6.

"Tableau" ("between six and seven hundred") was a careless one. There are 552 species named therein. Of these 193 were identifiable in 1825–6, 67 bearing references to figures from earlier authors (leaving out Soldani), 26 were figured by d'Orbigny in the eight plates published in the Atlas to the Ann. Sci. Nat., and forming part of the reprint as issued with the Models, whilst 100 were represented by the Models themselves. But in addition to these there are 158 references to figures in Soldani's Testaceographia,[1] which leave 245 species to be described as *nomina nuda*, whose names according to the strict rules of Nomenclature were liable to lapse, and were open to adoption by later authors. Between the years 1863 and 1871 Messrs. Parker and Jones, in their monumental series of papers on the Nomenclature of the Foraminifera, made a most painstaking and laborious study of the "Tableau Méthodique,"[2] in which they analysed, and to some measure identified, 302 species, leaving 250 undescribed.[3] As we shall see, when dealing with the "Planches inédites," Dr. Carlo Fornasini of Bologna, between the years 1898 and 1908, published a series of tracings, supplied to him by G. Berthelin, from d'Orbigny's original sketches for these "Planches," accompanied by diagnostic observations following upon the lines of Parker and Jones, and thus gave substance to the shadows of 246 further species, besides giving further figures of 83 which had been already described by Parker and Jones. I have appended a list of the species ignored by Parker and Jones and by Fornasini in Appendix G. Of these, one was shortly described in the Prodrome (Bibl. XV.), one has been subsequently figured, and one, *Alveolina quoyii*, was figured in one of the plates to the "Tableau," and was subsequently figured and diagnosed with some completeness by Carpenter in 1862. Thus the Rhizopodist of to-day is in a position to form an opinion as to the identity of all the

[1] It may be remarked that d'Orbigny was often lamentably careless in transcribing his synonymical references, and never is this crime more apparent than in his references to Soldani. Messrs. Parker and Jones (Bibl. XX.) undertook a laborious correction of these errors in the case of the 158 species which they analyse as having been taken from the "Testaceographia." They rightly observe (p. 152) that d'Orbigny might have drawn much more largely than he did on these stores with advantage to science. He appears to have selected from Soldani only such figured species as he recognized as having been found in the material at his command, and, whilst appending the localities of his own species, he entirely ignored the habitats affixed by Soldani to his species. This omission has been rectified with great care by Parker and Jones in this section of their work. De Férussac says that d'Orbigny had re-observed almost the whole of the species in Soldani's work, and studied them with the aid of much improved scientific appliances, with the result that he had more than doubled the number of species hitherto described (I., p. 103).

[2] Bibl. XVIII. to XX.

[3] At the conclusion of their labours they stated that 253 undescribed species must lapse; but they made the total number of the species in the "Tableau" "about 550," which accounts for the other two.

species described in the "Tableau Méthodique," with the exception of three. The analyses come out as follows :—

Species described only by Parker and Jones	218
Species described only by Fornasini	246
Species described by both Parker and Jones and Fornasini	83
Species known and figured before the "Tableau," or subsequently, but ignored by Parker and Jones and Fornasini	2
Species never figured or described by anyone	3
	552

Regard being had to the fact that the "Tableau Méthodique" was practically in its entirety composed at La Rochelle, and that the early studies of d'Orbigny were made at Esnandes, it is not a little remarkable that he recorded so very few species of recent Foraminifera from that neighbourhood. I have noted (*supra*, p. 11) that he only gave La Rochelle as the locality for two species out of his 552, whereas Earland and I have identified no less than 178 species from the neighbourhood.[1] The following list gives the sum of what may be called neighbouring habitats cited in the "Tableau" :—

L'Océan sur les côtes de La Rochelle (2)—
Globulina gibba, p. 266, No. 20.
G. sulcata, ibid. No. 21.

Toutes les côtes de l'Océan (1)—
Rosalina globularis, p. 271, No. 1.

L'Océan sur les côtes d'Europe (3)—
Rotalia beccarii, p. 275, No. 42.
Truncatulina tuberculata, p. 279, No. 1.
Nonionina crassula, p. 294, No. 7.

Les côtes de l'Océan à Noirmoutier (1)—
Turbinulina corallinarum, p. 275, No. 48.

L'Océan sur les côtes de France (10)—
Planulina dubia, p. 280, No. 2.
Polystomella crispa, p. 283, No. 1.
P. oceanensis, p. 285, No. 8.
Spiroloculina nitida, p. 298, No. 4.
Triloculina flavescens, p. 300, No. 11.
T. oblonga, p. 300, No. 16.
Quinqueloculina subcarinata, p. 301, No. 10.
Q. subrotunda, p. 302, No. 36.
Q. pulchella, p. 303, No. 42.
Q. seminulum, p. 303, p. 44.

[1] See p. 11, and Section XVII.; see foot-note on p. 86.

Of the remainder of the *recent* Foraminifera the records are as follows :—

Mediterranean, 62.

Adriatic, 162. (In the Vienna Memoir he says he found 140 only).[1]

English coast, 6.

Antilles, 14. (In the Vienna Memoir he says 118 (*sic*, should be 117, see p. 44), but this included the species from Ramon de la Sagra's material, and, as we shall see, he had some doubts in 1839 as to some of these earlier records.)

Madagascar, 9. (In our Kerimba Monograph we gave a list of these and of those recorded by him from the neighbouring island of Mauritius.)[2]

Various tropical localities, 73.

Ballast-sand (" *sable de delestage* "), 6. (This was probably gathered from ocean-going vessels in the harbour of La Rochelle.)

The fossil species recorded are from a great number of localities, especially from the Soldani material (see p. 6) from Sienna. Of what may be called local fossils the records are :—

Environs de Bordeaux, 38.
Environs de Dax (Landes), 31.
Pauillac (Gironde), 5.
Calcaire Jurassique de la Charente Inférieure, 1.

A year after the publication of the "Tableau Méthodique," de Férussac published in his "Bulletin" a list of Corrections and Additions, to which I have already referred (see p. 23).[3] In this he gives a list of twelve "Espèces restées inconnues à M. d'Orbigny"; he gives eight pages of Errata and Addenda consisting of revised or amplified synonymies, and nine further species to be added in their places from previous authors. (See Appendix H.) In his opening paragraph he observes that it is necessary to publish these corrigenda as soon as possible, and adds, "These rectifications, the publication of which was agreed upon with him, are the more necessary for the reason that people might think that d'Orbigny did not admit the validity of the species which he did not cite, seeing that he announced a complete 'Tableau,'" and points out (see p. 23) that they were due to the hurry of his

[1] XII., p. xv.

[2] XXVII., p. 544. Fortunately the identity of the Madagascar material was preserved when the cellars of the Musée de Paléontologie were flooded (see p. 13), by the attention which had been paid to it by Schlumberger.

[3] "Additions et Corrections au Tableau Méthodique de la Classe des Céphalopodes, par M. d'Orbigny. Ordre des Foraminifères, par M. de Férussac," in Bulletin des Sciences Naturelles et de Geologie. Deuxième Section du Bulletin Universel des Sciences et de l'Industrie, x. (1827) p. 175.

departure for South America.[1] But d'Orbigny did not accept this statement at all. He took the first opportunity of saying[2] that de Férussac published these "pretended rectifications which I am far from adopting" unknown to him, and that he had purposely omitted the figures which de Férussac cites as being too uncertain for admission into his system; he points out, however, that his classification was in no way altered by them. As we shall see (p. 42) he was at this time much annoyed with de Férussac (who had died in the previous year), for not giving him credit in his "Apercu historique sur les Céphalopodes" (Paris, 1834) for having anticipated the discoveries of Dujardin.[3]

When d'Orbigny returned from South America he found that several zoologists had been taking liberties with his work, and in his Introduction to the Cuba Memoir he deals with some of them. De Blainville in his "Faunes Francaises" (Paris, 1828) had not followed his divisions, but had scattered some of d'Orbigny's genera among his different families, not keeping the whole of the so-called microscopic Cephalopoda distinct as an Order.[4] Cuvier, on the other hand, separated them under the name Camerines in the second edition of his "Règne Animal" (Paris, 1828–30),[5] referring the student to the "Tableau Méthodique." Rang in 1829,[6] and Fischer de Waldheim in the same year,[7] had adopted d'Orbigny's classification without restriction.

Deshayes in 1830[8] in the "Encyclopédie Méthodique," in his article on Cephalopoda, and others, was the first zoologist to attack d'Orbigny's whole plan of classification, which he declared

[1] He corrected some of d'Orbigny's misprints, e.g. *Nodosaria scorpionus* (I., p. 255, No. 40) = *Nodosaria* (*Reophax* of Montfort, genre 83, vol. i., p. 330) *scorpiurus*. (See de Férussac's "Corrections," p. 179.) He adds, "Ajoutez à la synonymie *Orthoceras scorpiurus* Blainv. Malac., p. 379." The pagination of the "Tableau Méthodique" in these "Corrections" is taken from one of the reprints, and therefore differs from the original work.

[2] VII., p. xxiv.

[3] VII., p. xxvii.

[4] De Blainville was responsible for vol. v., "Mollusques," in the "Faunes Françaises ou Histoire naturelle générale et particulière des Animaux qui se trouvent en France." The work was announced for publication in ninety livraisons, of which twenty-nine only were published, without dates, between 1821 and 1828. It is difficult to work out the order and chronology of the instalments from the available copy in the British Museum. De Blainville's volume seems to constitute the eighteenth livraison, published c. 1827–8, in which the majority of the Foraminifera are included in his third Order "Les Multiloculés." He says (p. 23), "Nous disposerons les genres assez nombreux que M. d'Orbigny le fils a établis dans cette famille d'après la disposition des loges qui constituent la coquille, mais sans pouvoir assurer que cet ordre est naturelle." His Section I., beginning with Nodosaires, comprises most of d'Orbigny's Families; Section II. comprises the Milioles; and Section III. the Planulaires (*Frondicularia*). (See d'Orbigny's analysis in VII., p. xxiv.)

[5] Vol. iii., p. 22. This edition was revised and augmented by P. A. Latreille.

[6] P. S. Rang, "Manuel de l'Histoire Naturelle des Mollusques," Paris, 1829, p. 97.

[7] Fischer de Waldheim, in Bull. Soc. Imp. Nat. Moscow, i. (1829) p. 329.

[8] Vol. i., 1827, p. 224. As to this date see Sherborn's Bibliography, sub. Lamarck.

was "vicious," "unnatural," "defective," and attacked d'Orbigny's genera, which, says d'Orbigny, "he considered doubtful because he did not know them, and others as wrongly based because he confused them with other distinct forms."[1] D'Orbigny and Deshayes had been warm friends, but d'Orbigny never forgave him for this attack; he expresses his regret that Deshayes could not understand the Models, and that he had gone beyond his province of the Mollusca which he did understand, that if he had not done so "he would not have tried to upset in one day the result of six years' work upon animals quite different to any he knew," and which d'Orbigny (in 1839) clung to as being generally adopted in Europe, whilst the classification of Deshayes had not been followed. D'Orbigny was particularly sore upon a point upon which, as it happened, Deshayes was perfectly right, namely the close relationship, if not the identity, of *Frondicularia* and *Flabellina*. He continually returned to this point in his later works,[2] relying on their occurrence in different geological strata, which (as we have seen, *ante*, p. 17) was always for him enough to remove a closely allied form to a new genus or species. It must be confessed that the arrangement suggested by Deshayes for the Foraminifera, which he called Polypodes, was the precursor of the now generally accepted classification. "Finally," said d'Orbigny,[3] "M. Deshayes not having adopted like me the plan of growth of the shells as the basis of his classification, has gone off upon another tack, which has led him to a method of which I confess I have hitherto in vain endeavoured to discover the basis."

Menke in 1830[4] had adhered to the d'Orbignyan classification of the Foraminifera, which he renamed *Trematophora*.

D'Orbigny, as we have observed, clung to his classification to the last, though he amalgamated some of his genera and abandoned some of his sub-families, such as Mucronina (= Nodosaria),[5] Soldania, Planularia (= Cristellaria), Gyroidina, Planulina (= Anomalina), Citharina (= Vaginulina).[6] In 1844 he repeated,[7] "the arrangement of the segments or chambers of the shell which contains

[1] VII., p. xxv.

[2] VII., p. 19; X., pp. 7, 19, 23; XII., p. 93. See also XVII., p. 164.

[3] VII., p. xxvi.

[4] C. T. Menke, "Synopsis methodica Molluscorum." Pyrmont, 1830, p. 4.

[5] VII. p. 12 (note).

[6] At the same time, whilst d'Orbigny was instituting hundreds of new species on what seem to us to-day to be very inadequate grounds, he did not hesitate on occasion to amalgamate species differentiated by his predecessors. As, for instance, *Orbiculina numismalis*, in which he "lumped" *O. angulata* (Lam.), *O. adunca* (F. & M.), and *O. uncinata* (Lam.) (I. p. 306). Carpenter remarks upon it:—"He arrived at this result, of the truth of which I am myself well assured, by the comparison of a great number of specimens, a process which it would have been well for science if he had more constantly adopted" (XVII., p. 93).

[7] XIII., p. 665. See also XVII., p. 6.

them will be the basis of our classification, since it represents the ultimate relationships of the zoological characters of the animal, and of its shell; . . . as for the genera, I have determined them according to the plan of growth, combined with the number, the form, and the positions of the apertures of the terminal chamber." Carpenter at the end of his onslaught upon the d'Orbignyan classification says:—"Some suspicion of the unsoundness of his fundamental assumption that the geometrical plan of increase is a character of primary value appears to have crossed the mind of M. d'Orbigny; for he admits that affinities exist among all the orders, which arise out of a change in the plan of growth that is liable to occur in many types with the advance of life." [1] The fallacy of d'Orbigny's system, in the light of our later knowledge, is nowhere more apparent than among the sub-families of the family Lagenidæ, in which Lagena alone is a Monostègue; Glandulina, Nodosaria, Orthoceras, Dentalina, Frondicularia, Lingulina, Rimulina, Vaginulina, and Marginulina, are Stichostègues; Cristellaria, Flabellina, Robulina, and Uvigerina are Hélicostègues; and Dimorphina and Polymorphina are Enallostègues. "In no group," says Carpenter, "is the artificiality of his method of classification more apparent; and there is none in which the results of painstaking research have been more fruitful in elucidating the close natural affinities of organisms, whose diversity of form at first sight appears to require their wide separation from each other." [2] The same remarks may be applied with almost equal force to the family of Rotalidæ (see p. 74). We can but bear in mind that d'Orbigny to the end of his life, deeply occupied with vast geological works, never studied the internal structure of the shell, or the living animal, in spite of the pioneer work in this direction of Dujardin (see p. 37).[3] But when criticism, even so pungent as that of Carpenter, has exhausted itself, we come back to Albert Gaudry's just appreciation of d'Orbigny's work:—"Before him people had none but confused ideas on the Foraminifera; the genera had been multiplied without discernment; it is he who in truth caused this order of animals to be known." [4]

It must be confessed that d'Orbigny held strange views, from which the extent and variety of his material ought to have protected him, upon the distribution of living forms. He expressed the opinion that whilst the Hélicostègues, the Enallostègues, and the Agathistègues are to be found all over the world, the Stichostègues are common in the Adriatic, but rare in warm seas, and entirely absent in Oceania and in the Pacific Ocean: whereas the Entomostègues are common in the Atlantic and Pacific Oceans, but practically non-existent in temperate zones, and quite absent

[1] XVII., p. 6. Carpenter is referring to a passage in the Vienna Memoir (XII., p. 17), which bears this interpretation.
[2] XVII., pp. 55, 161. [3] XVII., p. 42. [4] XVI., p. 833.

. ESNANDES MAISON D'ORBIGNY .

Plate V. Esnandes : The House of the d'Orbigny family (1914).

from cold areas.[1] The complete fallacy of this hypothesis, founded, indeed, upon a fallacious system, has been amply demonstrated since his time.

His studies led him to the final conclusion, based upon the zoological characters of Echinoderms and Polyzoa, that the Foraminifera must be placed zoologically between them, being inferior in organization to the former, but superior to the latter. It was left for Dujardin to settle this matter, and he did so, but d'Orbigny in his latest works retained and expressed the above view.[2]

In conclusion, I can but express the regret, which must be shared by all students of the Foraminifera, that d'Orbigny's geological work prevented the completion and publication of his "grand ouvrage," and that the exquisite drawings which he made to accompany it were likewise left unfinished, and have remained to this day the "Planches inédites."

V.—The "Planches Inédites."

Latreille in his Report (as we have seen, p. 22) stated that seventy-three plates accompanied the "Tableau Méthodique"; d'Orbigny himself in the Cuba Memoir says that his Order was "based upon the study of over six hundred species, of which the drawings have been submitted to the Académie."[3]

It is not too much to say that these plates are quite unknown to the present generation of Rhizopodists. Terquem, writing in 1882,[4] states (with a wealth of exaggeration), "He had drawn all the species mentioned in the 'Tableau Méthodique,' and had thus prepared 300 quarto plates. The material and documents thus collected by d'Orbigny remained for a long time unused, and it is only recently that their importance has been recognized; the types of d'Orbigny have been carefully arranged in tubes and put in order; the 'Planches inédites,' in which the figures bear the numbers assigned to their species in the 'Tableau,' were used for the determination of the Tertiary fossils, which could be at the same time compared with the types;" and he appends a "note" to the effect that "The *Planches* having remained *inédites* and the types unknown, the result has been that all the authors who have

[1] VII., p. xliv. [2] XII., p. 17; XIII., p. 669.

[3] VII., p. xxii. He was including in this number not only the species instituted in the "Tableau," but also the later species which make their appearance in the Memoirs published in 1839–40.

[4] O. Terquem, "Foraminifères de l'Eocene de Paris," Mem. Soc. Geol. France, ser. 3, ii., Mem. 3, p. 11.

had occasion to mention the 'Tableau Méthodique' have, as a fact, only been able to mention the names with the page and number of the Ann. Sci. Nat.; they have not been able to indicate any means of comparison, either with figures or with text to support the determinations, excepting as regards the species which d'Orbigny took from the publication of Soldani, to which he has applied new names." [1]

Here the matter rested. The "Planches" are referred to by Sherborn in his Bibliography (London, 1888, p. 105), with a note from Albert Gaudry that "they are preserved in my laboratory in the Museum." It was here that, not without some little difficulty, I found them in May 1914. Meanwhile G. Berthelin had made a careful study of them for his own use, and after going through them with the invaluable papers of Parker and Jones above referred to, had made tracings, not from the plates themselves, but of d'Orbigny's original outline sketches for them, and these passed on his death in 1897 to Professor Carlo Fornasini of Bologna.[2] This eminent authority upon the Foraminifera, in a paper published in that year,[3] tells us: "I cannot find words in which to express my veneration for the memory of G. Berthelin, who died 27th August of this year. He remembered me delicately and affectionately by giving me a precious volume. He left a note saying, 'Among my books will be found a large quarto portfolio, labelled, "d'Orbigny Tableau Méthodique"; it is entirely in manuscript and contains plates of tracings of species not published by d'Orbigny. I desire that it may be sent in my name to M. Carlo Fornasini.'" They could not have reached better hands, for, as stated (*ante*, p. 27), between the years 1898 and 1908 Fornasini published facsimilies of the whole of these tracings in a long series of invaluable articles (see Appendix I.), giving a complete Index to the entire series in the concluding paper.[4]

I have made it my duty to make a minute and categoric examination of these "Planches," in Paris, and compare them with the "Tableau Méthodique," and it is my intention to bring about the publication of the whole of them, with the permission of the French authorities, an intention which would have been by now well on its way to complete realization had it not been for the disastrous interruption of the European War.

[1] It will be observed that Terquem ignored the labours of Parker and Jones in their "Nomenclature."

[2] See analysis on p. 28. Berthelin drew for the most part only those species which had been left untouched by Parker and Jones. There were 246 of these, but he also made (*vide supra*) tracings of eighty-three which Parker and Jones had also dealt with.

[3] C. Fornasini, "Le Sabbie gialle Bolognesi e le ricerche di J. B. Beccari," Rend. di Sessioni della R. Acad. d. Sci. dell' Istituto di Bologna, Ann. Accad. n.s., ii. (1897–8) p. 9.

[4] Mem. Acc. Sci. Ist. Bologna, ser. 6, v., p. 41.

The "Planches inédites" are contained in two large cardboard cases, preserved in the room of Professor Marcellin Boule, Director of the Museum of Palæontology at the Jardin des Plantes.[1] I take this opportunity of recording an expression of my warm gratitude to Professor Marcellin Boule for the courtesy with which he placed these plates, as well as the d'Orbignyan types, at my disposal during the several days which their examination occupied, and for his untiring kindness since that date in assisting me in the preparation of this Memoir, by obtaining for me the portraits of d'Orbigny, and the reproductions of the "Planches" which illustrate it, besides giving and obtaining for me a great deal of information upon its subject.

Each genus has a brown-paper cover to itself, which contains everything which d'Orbigny had prepared. The contents of these files come under the following six categories :—

(i) Finished plates in which the species are beautifully drawn from all necessary aspects, in pencil and wash, delicately tinted and highly finished. I have had a finished plate of Rosalina, and of Rotalia, reproduced (reduced by half) to illustrate this Memoir (Plates VIII and IX). They suggest being modelled somewhat upon the plates in Fichtel and Moll's work, for which, as we shall see (p. 56), d'Orbigny had the highest admiration, each being framed in a thick black line. Each figure is numbered, and the names of the species figured are written at the foot of the "Planche," each name being followed by the number to which it corresponds in the "Tableau Méthodique." In each group of species-figures a dot or other mark represents the "natural size" of the species.

(ii) Incomplete plates containing one or more finished drawings, the rest of the species intended to occupy the plate being indicated more or less perfectly in outline. Sometimes these are finished as regards the pencil work, only wanting to be tinted. These have the figure-numbers, and names and reference-numbers at the foot as in the finished plates.

(iii) Sheets on which the black frame is drawn, containing only the pencil outlines of the species intended to occupy it. These are numbered and referenced the same as (i) and (ii), and a pencil number refers to sheets in the portfolio, where the preliminary drawings and sketches for the plates (iv) are to be found. The locality of origin of the species is generally added in pencil.

(iv) Sheets of drawings more or less highly finished in black and colours, but not so perfect as the finished drawings. These were d'Orbigny's first *finished* drawings and constituted a book of

[1] The first case contains also d'Orbigny's original MS. of the "Tableau Méthodique."

reference, having headings such as "Textularia, Planche 30, Z. 2" (Z. 3; N. 4, etc.), and each species has a number attached apparently referring to a note-book. These are in no way consecutive. On these drawings the name of the species and its place of origin are always written in ink. At the foot of the sheet the words "Coquilles libres" nearly always appear (see p. 23). I think the letters N. G. Z. etc. refer to Soldanian figures.

(v) Sheets full of d'Orbigny's original sketches in outline made under the Microscope. They are on small odd scraps of paper, made originally in pencil and afterwards inked over. Surface decorations and markings are only partially indicated, as in Fornasini's reproductions, which are tracings by Berthelin from these outlines, selected as I have indicated above.[1] Notes in pencil or ink are scribbled upon these sketches, as to the texture and markings of the shells,[2] the name proposed to be given to it, and the place of origin. Each one bears a number apparently referring to a note-book.

(vi) Sheets containing figures cut from published works, added later by d'Orbigny, from "Dict. Sci. Nat.," "Cuba, 1839," "Vienna, 1846," etc. The figures published in the eight plates of the Atlas to the "Tableau" generally appear on these sheets.

It would appear that (v) were made from the specimens direct; (iv) were made from (v) (some perhaps from earlier authors); whilst (i) and (ii) were made from (iv). The whole of the plates could easily be finished by a competent artist from (iv) and (v). Roughly speaking, there are 70 finished plates (i), 7 partly finished (ii), and 79 framed and outlined plates (iii), making 156 in all. The only "Planches" which are incapable of being completed with certainty are the two, coming under (iii), destined for the confused genus "Soldania." (*Vide post*, Appendix F., note 21.) These two consist of frames with outlines, but there are no drawings or sketches in the files, and no names, numbers, or references on the sheets, nor have I been able to find type-specimens of any species referred to "Soldania" either in Paris or at La Rochelle.

In the Alveolina file only, there is a sheet of synonyms from

[1] Sometimes, it must be confessed, Berthelin's tracings were too faithful, and remind one of the Chinese tailor who conscientiously reproduced the patches in the worn trousers he was given to copy. D'Orbigny made corrections on these sketches *currente calamo*, and these are faithfully reproduced in Berthelin's tracings. Cf. the figure of *Bulimina arcuata* (No. 11 in Appendix I., pl. i., fig. 12), where d'Orbigny mistook a foreign speck for an aperture and put it in. He subsequently put his pencil through it, and this is apparent in Dr. Fornasini's figure. D'Orbigny's method of indicating surface markings is clearly shown in the reproduction of the sketch of *Rotalia dubia* (Plate X., fig. 5), where the papillæ which cover the surface of the shell are merely indicated in the manner described.

[2] As, for instance, "*plane*," "*glabre*," "*émaillée*," "*assiculée*," etc.

earlier authors. Besides the files of the species of the "Tableau Méthodique" there are files in the cases for some of his later genera, e.g. Asterigina, Candeina, Dactylopora, Gaudryina, Lituola, Ovulites, Verneuilina. These have only figures cut from publications (vi) in them.

It will be remembered that de Férussac announced to the Académie that d'Orbigny had finished "nearly half of the plates for his great work,"[1] and that Latreille announced that seventy-three plates were laid before that body. These numbers agree roughly with the above enumeration.

D'Orbigny devoted his skill as a draughtsman to every branch of science that he took up. Gaudry tells us that he made drawings with the most minute detail of nearly 900 species of Bryozoa;[2] and there are a number of cases in Professor Marcellin Boule's study, each as large as those containing the Foraminifera, filled with equally exquisite drawings of fossil Invertebrata.

VI.—The Revelations of Félix Dujardin.

Concerned as we are with the earliest records of the modern era of the study of the Foraminifera, we cannot proceed further without pausing to consider what may really be called the *discovery* of the Foraminifera in 1835 by Félix Dujardin. During the nine years which had elapsed since the publication of the "Tableau Méthodique" no general work had appeared dealing with the group — excepting, of course, the corrections and addenda of de Férussac.[3] D'Orbigny had been in South America, and had landed in France on his return on February 2, 1834. Meanwhile Dujardin had been making what must be admitted to be the first systematic observations upon the living animal, for, as Carpenter has remarked (loc. cit., *ante*, p. 11), d'Orbigny's observations at Esnandes were relatively superficial, and he had been content to

[1] I., p. 119. [2] XVI., p. 832.

[3] The Foraminifera had been noticed and figured, always, however, as microscopic Cephalopoda, in the works of Capt. T. Brown ("Illustrations of the Conchology of Great Britain and Ireland," London, 1827); of Nilsson ("Petrifacta Suecana formationis cretaceæ," Lund., 1827); of the Rev. J. Fleming ("A history of British Animals," Edinburgh, 1828); of Deshayes ("Histoire Naturelle des Vers.," Paris, 1830–32); and "Description des Coquilles caractéristiques des Terrains" (Paris, 1831); and several other works for which the student may refer to Brady's Bibliography in the 'Challenger' Monograph. In 1828 Deshayes had published in the Ann. Sci. Nat., xiv., p. 225, a "Mémoire sur les Alveolines" (referred to, *ante*, p. 19), and in 1829 Fischer de Waldheim had published a paper on his discovery in Russia of the genus Fusulina (Bull. Soc. Imp. Nat., Moscow, i., p. 329). In none of these works had any significant contributions been made to our knowledge of the group.

rest satisfied that the extruded pseudopodia were the tentacles of a Cephalopodous animal. The first announcement of Dujardin appeared in the month of January 1835 (Bibl. II.). In this note he recorded that he had had opportunities of observing living specimens of Miliolidæ (Triloculina, Quinqueloculina), Vorticialis (= Polystomella), Rotalidæ, Truncatulina, Cristellaria, and others; and he was "convinced that the shell was not internal, but, on the contrary, external, and that the animal, entirely wanting in organs of locomotion or even respiration, was composed of a succession of segments or lobes, which proceed by enlarging and enveloping one another successively. No fleshy part (*partie charnue*) is visible on the exterior excepting when a new segment is produced and is not yet invested with shell-matter (*encrouté*)." He crushed the shells, and observed that the substance of the animal is as simple as that of Planarians (*planaires*), and even of Hydra, and he was the first to decalcify the animals with weak acid, and observe that the body is "formed of a series of segments occupying all the chambers of the shell, capable of being unrolled, and presenting an aspect differing according to the genera. Thus in Miliola the segments are like spatulate leaves folded longitudinally; in Polystomella (*Vorticiale*)[1] they are pieces in the form of a V, of which the two arms embrace the preceding pieces and are bordered by lobes or crenelations; in Cristellaria the segments are crescentic, and connected with one another by fleshy tubes whose number varies from one to four, and increase successively in series of five segments. On the other hand, the Rotalia, the 'Melonies' (= Alveolina),[2] Truncatulina, etc., leave, after the treatment with acid, a transparent membrane which envelops the segments and prevents their isolation, and, furthermore, the last two have this membrane furnished with prominent tubes in the intervals of which the formation of the shell takes place." As a result of these observations he concludes that these creatures cannot be classed either with Mollusca or with any of the groups already established in the animal kingdom, and proposes for them the name "Symplectomères," indicating thereby that they are "formed of parts folded together."[3]

In June of the same year he returns to the subject (Bibl. III.).

[1] The generic name Polystomella was given by Lamarck in 1822 in substitution for his original name Vorticialis (Lamarck, "Extrait Cours Zool.," 1812, p. 122; and "Histoire des Animaux sans Vertèbres,' Paris, vii. (1822) p. 625). De Blainville in 1825 ("Manuel de Malacologie," 1825–27, p. 374, pl. vii., fig. 6) used the term Vorticialis, but d'Orbigny in the "Tableau Méthodique" restored Lamarck's name Polystomella (p. 283).

[2] As d'Orbigny justly pointed out in one of the first notes which he published on his return from America, Dujardin had mistaken something else for this genus, which is not to be found in the living condition on the shores of France.

[3] This notice appeared also in the Bulletin de la Soc. des Sciences Naturelles de France, No. 3, 1835.

He points out that the chambers of the shells are filled with a very contractile rose or orange-coloured animal-matter of the consistency of thick mucus, capable of extension in threads, and filled with irregular granulations. From the interior of Miliola he had seen protruded a soft mass analogous to the interior substance, which changed its form slowly under the Microscope.[1] He had made some observations on Miliolina, Cristellaria, and Vertebralina living on algæ at a depth of one metre. He observed that when a washing of these animals was placed in a glass vessel one sees them after a few hours attached to all its sides, independently of the direction of light, from which he concluded that they are not heliotropic.[2] He observed the pseudopodia spread out and radiating from each "centre of adherence," and that, measuring ·01 at their bases, they extended to a distance five times the diameter of the shell, becoming of extreme tenuity. By means of these pseudopodia the animal crawled at a rate of about 5–7 mm. in an hour. He made the further highly interesting observation that in time the animals crawl up to the surface level of the water and "continue to crawl along its surface hanging below it like certain gasteropod mollusca." This observation was made by myself in my tanks at Selsey in the year 1915, and does not appear to have been made by any other zoologist between 1835 and that date.

Dujardin pointed out, quite accurately, that Polystomella crawls more slowly than Miliolina, and that the form to which he had given the name *Gromia oviformis* was slower still. His account of the formation of the pseudopodia and the use made of them in crawling (*reptation*) is complete, and since his day nothing has been added to our knowledge of this phenomenon. "One cannot see in this," he says, "veritable tentacles; it is a primary animal substance which extends itself and grows somewhat after the manner of roots; the extreme slowness of the movement alone is sufficient to prove this." He then notes the fundamental difference in the manner of the extrusion of the pseudopodia in perforate and imperforate genera. He concludes, again, that they must be classed among the lowest forms of life, and regard being had to the above observations he abandons the term "Symplectomères" and proposes the name by which the group has since been known, "Rhizopoda."[3]

In a third note, published in November of the same year (1835)

[1] It will be observed that this is a new observation. He had previously said that no part of the body was extruded excepting for the formation of new chambers.

[2] This is not entirely accurate; a certain measure of heliotropism has been established by later observations.

[3] This paper attracted a good deal of attention on its publication. See notices in Le Temps (June 24) and l'Echo du Monde Savant (June 26).

in the Comptes Rendus (Bibl. IV.), he records having successfully kept Foraminifera from the English Channel alive in Paris, and calls attention to the fact that the pseudopodia are "of a glutinous consistency, almost resembling molten glass," with nodosities which move in one direction or the other; they are retractile, liable to ramify, to anastomose, and to coagulate, serving as feet by which the animal crawls, and by their appearance of radiciform fibres well justifying the name Rhizopoda." He observes that the body-plasm is identical in all species, and that it never leaves the shell excepting after the death of the animal, and he invites inspection of these phenomena by members of the Academy.

These three notes, important as they are, are really prolegomena towards a much more extended paper on the subject which was published in the Ann. Sci. Nat. in December of the same year (Bibl. V.). In this he describes how he kept Foraminifera alive in his tanks at Toulon through July and August, 1834, and others from the Channel which, collected in November, were living "in renewed sea-water" in Paris at the end of February, after all the Isopods, Annelids, and Crustacea were dead. He describes *Gromia oviformis* at length (p. 345), (and gives an admirable figure, op. cit. pl. ix. fig. 1) from tufts of *Jania rubens*, from the Mediterranean, laying stress on its rate of movement, which he states to be 1 mm. in 33 minutes. These *Gromia* must have been moribund, my observations of several years giving an average rate of progression of at least 1 cm. in an hour.[1] Nevertheless, Dujardin's notes on keeping Foraminifera alive, in this paper, may with advantage be studied by observers of these organisms in the present day. He goes on to describe the living Miliolina, and gives us the interesting information that he had shown them to d'Orbigny, on his return from South America, who recognized in the pseudopodia his "*tentacules nombreux*" of 1825,[2] blaming the imperfections of his Microscope for not having recognized their true nature.[3] Dujardin observed —and his observation has been verified by myself and others— that when a Miliolid is dying it extrudes its protoplasm in the form of "rounded and more or less symmetrical lobes," or in an expanded mass, a circumstance which had led de Blainville to connect the creatures with Planarians (*planaires*). The description which he gives in this paper (p. 348) of the protrusion of protoplasm and formation of pseudopodia is, as far as my researches enable me to say, more minute and exact than any that has ever

[1] XXVIII., p. 232. [2] I., p. 245.

[3] V., pp. 346–7. (Note.) See p. 10, where I have discussed d'Orbigny's early Microscope. The instrument which he used in his later work is now in the possession of Mme. Henri d'Orbigny, who has favoured me with a photograph which is reproduced on Plate VI, fig. 2. The maker is unknown, but Mme. d'Orbigny has understood that it was specially constructed for d'Orbigny after his return from South America in 1834. This opinion is entirely borne out by what we know of the French Microscopes of that date.

Fig. 1.

Fig. 2.

Fig. 1. The "Fleuriau de Bellevue" microscope, preserved at La Rochelle.
Fig. 2. D'Orbigny's later microscope, in the possession of Mme. Henri d'Orbigny.

been published since his day;[1] and he calls attention to their extreme tenacity when the animals are disturbed or the vessel containing them is shaken.

The question of their modes of nutrition greatly exercised his mind, and he arrived at no conclusion, stating with some pertinence "ce n'est pas expliquer une fonction que de lui assigner un appareil." In like manner he fails to come to any definite conclusion as to the reproductive processes of the Foraminifera, though he seems (p. 351) to have observed the development of amœbulæ inside a Miliolina. Finally, in this paper he notes the presence of chitinous linings to shells, both perforate and imperforate; he seems to anticipate Butschli's observations on the streaming movements akin to those of protoplasm in fine emulsions (p. 355), and for protoplasm he invents the term "sarcode," which was used for many years to designate the protoplasmic body-substance of the Rhizopoda.[2] How far his observations applied to all the forms described by d'Orbigny was, as we shall see (*post*), a matter which gave him some doubt and difficulty.[3] In this fourth paper of 1835 Dujardin first announced his recognition of the fact that *Polytrema miniaceum* (Pallas) was not a Zoophyte, but a true Foraminifer, an observation which has escaped all writers on the group, except one or two, who date his discovery from 1841 in the work abstracted in Appendix J. (see p. 102).

These observations of Dujardin, which, I agree with Carpenter, inaugurated "the third period with which our knowledge of the true nature of the Foraminifera really commenced,"[4] may be said to have been awaiting d'Orbigny on his return from South America. Later, in 1841, Dujardin found a place for the Foraminifera among the Infusoria (Bibl. VI.), though he appears to do so with some sense of incongruity. His work, "Histoire Naturelle des Zoophytes—Infusoires" (Paris, 1841), in the "Suites à Buffon," contains a recapitulation and amplification of the 1835 papers and need not concern us here, though it is of great interest, and I have given an abstract of these final conclusions in Appendix J.

Let us see what d'Orbigny had to say about it all when he returned and found his "Céphalopodes Microscopiques" tottering to an enforced abdication of their hitherto undisputed throne.

He took advantage of the first opportunity which offered itself, namely, in the Introduction to the Cuba Memoir, to point out[5] that whilst he was in America he had recognized that these

[1] Excepting, perhaps, the elaborate treatise of C. B. Reichert, "Ueber die Contractile substanz (*Sarcode, Protoplasma*) und ihre Bewegungs-erscheinungen bei Polythalamien und einigen anderen niederen Thieren," Abh. k. Ak. Wiss. Berlin, 1866, pp. 151–293 (pls. i–vii).

[2] Cf. XXI., pp. 436–7; XXIII., p. 166.

[3] See also XVII., p. 7.

[4] XVII., p. 7.

[5] VII., p. xxvii.

animals could no longer be classed with the Cephalopoda, but that owing to the press of work following upon his return he could not publish everything at once, and he was consequently anticipated by Dujardin, to whose scientific attainments he pays a well-merited tribute, recapitulating the facts recorded in his first note (Bibl. II.). D'Orbigny calls attention to the fact that he informed de Férussac of his change of opinion immediately upon his return (in February 1834), but that nevertheless de Férussac in his "Aperçu historique sur les Céphalopodes" (Paris, 1834, p. 81) republished the original error "without communicating with me," and cited the Foraminifera as the third Order of the Cephalopoda.[1] Both de Férussac[2] and de Blainville[3] expressed in Reviews the erroneous opinion that Dujardin was in too great a hurry to establish a new class of animals, the former adhering to the belief that the pseudopodia were probably Cephalopodan tentacles. D'Orbigny reviews the article in question (Bibl. III.) and calls attention to the discrepancy alluded to in note 1, p. 39, *ante*, but seems to have overlooked Dujardin's third note (Bibl. IV.). In reviewing Dujardin's fourth note (Bibl. V.) he suggests that the Foraminifer whose pseudopodia protruded from pores on the edge of the final chamber was a Peneroplis and not a Cristellaria, which may have been the case, though the aperture of Cristellaria might by looseness of diction (to which, however, Dujardin was not prone) be made to answer Dujardin's description. D'Orbigny, however, says most properly, "nevertheless these errors do not detract at all from the intrinsic merits of his observations, which are merely applicable to other genera."

We have seen (*ante*) that Dujardin exhibited his living Foraminifera to d'Orbigny; it is curious that the latter never saw or recognized the anastomosis of the pseudopodia. He records

[1] In his "Histoire Naturelle Générale et Particulière des Céphalopodes Acétabulifères vivants et fossiles" (Paris, 1834–48, i., p. 50). The omission is the more remarkable as de Férussac was cognizant of the work of Dujardin, to whom he refers, saving himself to a certain extent, however, by suggesting certain doubts as to whether the Foraminifera should form a single series, and that some have an internal, and others an external shell. De Férussac's work, however, shows other signs of carelessness; for instance, he says that Linné quoted in his synonymies Gronovius, Martini, Murray, Favanne, Schroeter, and Walker and Boys, none of whom published their works till long after the appearance of the twelfth edition of Linné. De Férussac had died in the year 1836, and d'Orbigny completed the work from notes confided to him by Mme. de Férussac in 1837. He points out in his substituted Introduction that de Férussac was always too ready to accept as new species any drawings submitted to him without comparing them with the originals, and that consequently many useless and misleading plates for his work were published in 1835, before d'Orbigny began his revision of the material. De Férussac published eleven "livraisons" of his work before his death (96 pp.), with the plates. The whole of these were suppressed by d'Orbigny, who wrote a new Introduction and Part I, dated 1839. From the twelfth "livraison" onwards the work was entirely d'Orbigny's.

[2] Magazin de Zoologie (Bulletin Zoologique), 1835, p. 104.

[3] Le Réformateur, No. 292, July 28, 1835.

Dujardin's observations,[1] and in another place[2] he says that they touch often, but are not amalgamated, and that one can follow them with difficulty until they separate again. But both here and in the Vienna Monograph[3] he falls back upon Dujardin for his general descriptions of pseudopodia.

It will be seen by what has gone before that d'Orbigny fully and generously admitted the work of Dujardin, and it is not true that (as the severe Carpenter says)[4] he ignored Dujardin's genus Gromia in all his subsequent writings. On the contrary, he calls attention to it in the Cuba Memoir,[5] both in the Introduction and the work itself, and again (practically in the same words) in the Vienna Monograph.[6]

The citation of these notes of d'Orbigny in the Cuba Memoir brings us naturally to the group of Memoirs published by him in 1839–40, of which the Cuba Memoir was probably, and is generally taken to be, the first in order of date.

VII.—The Cuba Memoir.[7]

The order of date in which the four Memoirs dated 1839–40 were actually published is wrapped in some degree of confusion, and can only be arrived at from casual notes to be found scattered through them, and from the synonymies of some of the species recorded in them. There is no doubt that immediately on his return from South America (February 2, 1834) he addressed himself to his great work on his voyage, which was not completed until 1847. He quotes the earlier volumes in the Cuba Memoir,[8] and later, in his Introduction, he says, "I am publishing at this moment three other local faunas—(1) that of the Canary Islands . . . ; (2) that of South America in my 'Voyage dans l'Amérique Méridionale (*une partie spéciale*)'; (3) fauna of the white chalk of the Paris Basin."[9] The Cuba Memoir is quoted in the Canary Islands Memoir; he says[10] that he is in course of publishing it, but as he quotes it by page in his synonymies[11] it was clearly

[1] VII., p. xxix.
[2] Op. cit., p. xxxiii (note).
[3] XII., p. 5.
[4] XVII., p. 63.
[5] VII., p. xxix and p. 2.
[6] XII., pp. 3 and 20.
[7] "Histoire physique, politique, et naturelle de l'Ile de Cuba par M. Ramon de la Sagra, Directeur du Jardin Botanique de la Havane, etc. Foraminifères par Alcide d'Orbigny," Paris, 1839, 8vo, pp. xlviii and 224. With an atlas of 12 plates, large folio. There was also an edition in Spanish, 4to (180 pp.), published in Paris in 1840. This latter is the edition referred to in Brady's works; the date and the pagination differing from the French edition have introduced some confusion in references and synonymies.
[8] Vol. i. See VII., p. viii, note (1).
[9] VII., p. xlvii, note (1).
[10] VIII., p. 123, note.
[11] E.g., on pp. 124, 134.

already published or in print. The date of the South American Memoir, as we shall see (p. 47), is settled by Troschel's epitome, and as he quotes in it both the Cuba and the Canary Island Memoirs by page[1] it evidently came third. In the Paris Basin Memoir he quotes all three.[2] This, therefore, is the order of precedence which they take in synonymies.

The Cuba Memoir is of course the most important, for it contains the whole of his knowledge as it stood at that date, and gives diagnoses of every genus of Foraminifera which he had hitherto observed in any material in his possession, whether it occurred in the Cuba material or not. A glance at the Tables in Appendix F. makes this plain. By this time, for instance, he was in touch with von Hauer, and he diagnosed genera from von Hauer's material which were not fully dealt with till the appearance of the Vienna Memoir in 1846. I have referred (*ante, passim*) to his general Introduction and the statement of his views and position included therein. Ramon de la Sagra had entrusted d'Orbigny with the arrangement of the zoological portion of his History of Cuba, and among the material was a small quantity of sand, the richness of whose Foraminiferal fauna struck d'Orbigny at once. He communicated with de Candé, a naval officer[3] stationed in the West Indies, who supplemented de la Sagra's material with sands from Cuba, Haiti, St. Thomas, Jamaica, Martinique, and Guadeloupe, and a year's assiduous work on the material proved to d'Orbigny that Cuba provides all the species to be found in any West Indian gatherings, besides many species not found elsewhere in the West Indies. He pronounces the dictum that Cuba cannot be compared for Foraminiferal fauna with any place in the world excepting the Adriatic.[4] He found in the Cuban sands 117 species, "one-tenth of the whole of the Foraminifera known up to the present day," and on these results being communicated to de la Sagra they agreed that the work "should serve as a basis for the study of the Foraminifera, comprehending my general views, my classification, and the succinct characters of all the genera," and he therefore gives an abstract of the general observations which he proposes to publish later in his "ouvrage spécial." He points out that until that moment nothing at all was known of the Foraminifera of the Antilles except about twenty species that he had noted in the "Tableau Méthodique."[5] At the end of his Introduction he makes the astonishing statement that so specialized are the Cuban forms that of the whole 117 he had only found five in other parts of the world, but this must be read in the light

[1] IX., pp. 22, 24, 26.
[2] X., p. 4, note (1).
[3] See Appendix E.
[4] VII., p. xii.
[5] I make it fourteen species. See p. 29.

of his views on species from different geographical areas (*ante*, p. 17). Very many of his peculiarly Cuban species have been swallowed up in the synonymies of other species of wide tropical distribution. At the same time it may be remarked that he recorded several species in 1826 (from material furnished by de Férussac, see p. 12), which he did not find again in the 1839 material.[1]

In the Cuba Memoir he first gave synonymies of species in the modern accepted form, the elaborate synonymy of *Orbiculina adunca* to which I have already referred (*ante*, p. 31, note 6) being a model in its way.[2] It is here, also, that he first shows the cloven hoof of his principles of nomenclature (see p. 92), claiming as his own, species of earlier authors which he had removed to other genera,[3] or whose names he had modified (see p. 66).

In this work he first introduces his family of Monostègues, giving as its representatives *Gromia* of Dujardin, and *Orbulina universa*, which he has found here and in several other localities. It is little short of amazing that he makes no mention of any species of Lagena, which makes its first appearance as Oolina in the South American Memoir, which indicates that this part at least of his work had gone to press before he tackled the South American material. It is astonishing that he deliberately ignored the Serpula (Lagena) of Walker and Boys (1784), the Lagenula of Fleming (1815), and the *Vermiculum globosum* (and others) of Montagu (1803), though we know that these works were well known to him.[4]

It is a curious reflection that de la Sagra's "History of Cuba" would have long been relegated to the limbo of practically forgotten works had it not been for d'Orbigny's concluding volume on the Foraminifera. The six volumes of the work itself may be bought for a few pence or shillings, whilst the small volume by d'Orbigny is practically unobtainable for as many pounds.

[1] Exempli gratia *Lingulina carinata* (VII., p. 21); *Cristellaria gibba* (VII., p. 40); *Calcarina calcar* (VII., p. 81); and several others. It is not a little remarkable that he found no species of Dentalina at all from any of the West Indian Islands (VII., p. 17).

[2] VII., p. 64.

[3] Thus, on p. 175, he calls *Vermiculum oblongum* Montagu, *Triloculina oblonga* d'Orb. It may be noted here that he always refers in his synonymies to the pagination of one of the reprints of the "Tableau Méthodique" issued with the Models, which is very confusing. Thus for this synonym he gives p. 134 instead of the original p. 300 of the "Tableau."

[4] He may well be excused for ignoring Denys de Montfort's 78me genre, *Lagenula floscula*, which is more like a vase or a pepper-pot than a Foraminifer (Conchyliologie systématique, Paris, 1808, i., p. 311). The fact that it was Montfort's was enough to make d'Orbigny fight shy of it. His views upon Montfort (which were shared by all other contemporary naturalists) are expressed without restraint whenever the opportunity offers. Cf. VII., pp. xvii, xix; I., pp. 103, 125, *et passim*.

VIII.—The Canary Islands Memoir.

The concluding paragraph of the preceding section applies with equal force to the "Histoire Naturelle des Iles Canaries," by P. Barker-Webb and Sabin Berthelot, published in Paris between 1835 and 1849.[1] These gentlemen submitted to d'Orbigny the Algæ that they brought back from the Canary Islands, together with a little sand which they had collected at Orotava. On the outward journey to South America (as he tells us in the South American Memoir, see p. 49) the officer in command of the ship "had omitted to regulate his chronometer" (!), and a stay of a few days was made at Teneriffe (August 9, 1826) for the purpose. The delay was hailed by d'Orbigny with almost lyrical enthusiasm. "One must be," he says, "naturalist and enthusiast to form a correct idea of what I felt."[2] He admits that the material was limited in quantity, but says that the results exceeded his hopes. He identified forty-three species, though of course he was far from having examined the sands of all, or of any large number of the Islands. The work is therefore essentially imperfect; d'Orbigny records that he only found seven Canarian species which were also to be found on the shores of France—all of them the commonest forms.[3] Besides these he only found two[4] which he had ever seen elsewhere. He compares the Canarian species with the fossil forms known to him on the lines which he afterwards elaborated in the Vienna Memoir.[5] The only genus which he describes as new from the Islands is Webbina,[6] and again we are confronted with the fact that the genus Lagena escaped him entirely in this material. It will be appreciated that this was his least important work as regards extent, but what there is of it is of equal value with the rest, and the execution of the plates is equally magnificent. One notices in this work two instances of a type of carelessness which is unfortunately frequent in d'Orbigny's works—a dis-

[1] The title-page of the section of this large folio work, devoted to the Foraminifera, is inscribed "105 Livraison 1839," and, below the publisher's notice, "1835–1849." The work was published "Under the auspices of the Minister of Public Instruction." In the completed volumes the contributions of d'Orbigny are in vol. ii., pt. 2, "Mollusques, Echinodermes, Foraminifères et Polypiers." Foraminifères: pp. 121–146, and three plates.

[2] XXII., p. 5.

[3] *Globigerina bulloides*, *Orbulina universa*, *Planorbulina vulgaris* (see p. 18), *Truncatulina lobatula*, *T. variabilis*, and *Textularia sagittula*. The seventh was his doubtful species *Quinqueloculina lævigata*, which he had only found in the Paris Chalk.

[4] *Lingulina carinata* and *Rosalina valvulata*, from the West Indies.

[5] He was already in communication (as we have seen, *ante*, p. 44) with Joseph von Hauer, as he tells us in a note on p. 122 (see also note 1, p. 54).

[6] VIII., p. 125. As to the species named after Barker-Webb and Berthelot, see p. 93.

crepancy between the name affixed to a species in the text and that in the legends or explanations of the plates. Thus in this work *Rosalina bertheloti* in the text is *R. berthelotiana* in the plate; and *Nonionina stelligera* in the text becomes *N. stellifera* in the plate. The name in the text, of course, stands.

IX.—The South American Memoir.

The "Voyage dans l'Amérique Méridionale" was the *magnum opus* of d'Orbigny's life, in the sense that it was the only one of his vast projected and commenced works which ever arrived at completion (see *post*, p. 59).[1] There exists some confusion as to its precise date, but as regards the section devoted to the Foraminifera it is certainly the last-issued of the 1839–40 Memoirs. In a note on p. 1 he tells us that he published the Cuba, Canary Islands, and Paris Basin Memoirs "last year." The Paris Basin Memoir was read before the Société Géologique de France on December 2, 1839, and published in their "Mémoires" in 1840. There is little doubt, therefore, that this latter work was issued early in 1840. In the month of June, 1840, Troschel published in Wiegmann's "Archiv" a combined abstract and translation of the Cuba, Canaries, and South American Memoirs, in which every genus and species described in the three Memoirs are brought together under their families; he (Troschel) says himself: "It seems to me most appropriate to bring together here all that is most interesting out of all three works."[2] Messrs. Sherborn and Woodward dealt with this vexed question in one of their many Bibliographical notes,[3] and agreed that for all practical purposes 1839 is the date to be assigned to this portion of the work.

The publication of the entire work in seven volumes folio, with

[1] "Voyage dans l'Amérique Méridionale . . . éxécuté pendant les années 1826 . . . 1833 par Alcide d'Orbigny . . . Onvrage dédié au Roi et publié sous les auspices de M. le Ministre de l'Instruction Publique (commencé sous le Ministère de M. Gnizot). Tome Cinquième, 52 partie. Foraminifères." Paris (Bertrand); Strasbourg (Levranlt); 1839.

[2] "Es scheint mir am Zweckmässigsten das Interessanteste aus allen drei genannten Arbeiten hier zusammenznstellen," Dr. Troschel. "Die Foraminiferen Amerika's nnd der Canarischen Inseln von Alcide d'Orbigny." Im Anszuge mitgetheilt von Dr. Troschel. In A. F. A. Wiegmann's Archiv für Natnrgeschichte, Jahrg. 6 (1840) pp. 398–462, Berlin. The last paper in the first half-yearly volnme.

[3] "The title-page of the 'Foraminifères' is dated 1839, the wrapper is dated 1843. Troschel in 1840 translated and printed the whole work. Apparently the whole work was printed by the Government, and was ready for pnblication by 1839, bnt for some reason or other was delayed. The fact that Troschel reprinted the paper, however, allows ns to take the original date of 1839, rather than to disturb the history of so many specific names."—C. Davies Sherborn and B. B. Woodward, in Ann. Mag. Nat. Hist., ser. 7, vii., pp. 388–9.

two atlases, occupied him from 1834 to 1847. His biographer, Paul Fischer, observes, "Nine volumes and about five hundred plates, relative to the most diversified subjects, hardly sufficed to make known the great quantity of material which he had collected. This immense work, says Élie de Beaumont, presents in an almost encyclopædic form one of the most extensive monographs that has been devoted to any region of the world." [1]

As we have seen (*ante*, p. 8), d'Orbigny was only twenty-three years old in 1825 when an English company was formed to fit out an expedition for the exploitation of the mines of Potosi, in Bolivia, and the authorities of the Muséum d'Histoire Naturelle decided to send out with it a "Naturaliste-voyageur." It was early in November, 1825, that Geoffroy–St. Hilaire intimated to d'Orbigny that he had, jointly with Cuvier, Brongniart, and other members of the Administration, proposed him for election to this post of honour, and his appointment thereto was ratified in the Séance of the Academy of November 14. D'Orbigny accepted at first with some reserve; he expressed a wish to devote a few years to preliminary studies in various branches of science. This, however, was not practicable, though the Administration agreed that he might remain for some months in France, and appointed him a salary up to the time of his departure.[2]

He tells us himself, "To wander all over South America under such flattering auspices appealed to me in the highest degree." By way of preparation for his voyage d'Orbigny set himself to attend the lectures and classes of Cuvier, de Férussac, Brongniart, Geoffroy-St. Hilaire, Cordier, and de Blainville, and made notes for his future guidance. Cuvier honoured him with verbal instructions as to his zoological studies, and placed the resources of the Cabinet d'Anatomie at his disposal. Alexander von Humboldt and Bonpland had made a scientific tour of South America from 1799 to 1804, in augmentation of the results obtained on the earlier voyage of Félix de Azara, and von Humboldt set d'Orbigny a large number of questions upon which further enlightenment was required, and obtained for him the grant of such meteorological instruments as he was able to take with him—which consisted only of barometers—besides giving him introductions to persons in South America who might be able to assist him in his work.[3] Indeed, it would appear that all the leading naturalists then in Paris helped the young "Naturaliste-voyageur" with their advice

[1] XXI,, p. 441; XVI., p. 830. D'Orbigny tells us himself that he was still working at it in 1844, when von Hauer invited him to make a special study of the Vienna Foraminifera (XII., p. ix).

[2] I have taken what seems of interest for the purposes of this paper from the biographical notices of Fischer (XXI.), Gaudry (XVI.), and Labonnefon (XXII.), and from his own narrative of the Voyage, vol. i. pp. 4–8, 15, 21.

[3] He pays a tribute to the advice and assistance of Cuvier and von Humboldt in his special work on "L'Homme Americain" (see note 2, p. 50; Introd., p. x).

Plate VII. Alcide d'Orbigny, from a Daguerreotype of 1843, in the Musée de Paleontologie, in Paris.

and encouragement. The authorities of the Museum voted him an annual sum of 240*l.* for the expenses of his voyage, whereupon Desfontaines, the Professor of Botany at the Museum, said to him, "Do not start on so modest a sum, you will assuredly die of hunger," and d'Orbigny set himself to work to obtain further grants in aid of his object. Labonnefon tells us, "The Duc de Rivoli was living then at La-Ferté St. Aubin. Though his avarice was notorious he could loosen his purse-strings when he foresaw a real advantage to science. D'Orbigny approached him and pleaded his cause so well that the duke accorded him a subvention of £120 a year up to 1830, and thanks to this the voyage became practicable." On May 27 he left Paris to make his farewells to his family at La Rochelle, reaching Brest from there, where he found he had to wait a month while the ship was being got ready.

He left France on board the corvette 'La Meuse,' sailing from Brest on July 29, 1826, and he tells us that he was very sea-sick for three days, and never suffered similarly again all his life. We learn from a note in de Férussac's Bulletin that he was accompanied by a friend, M. Trion, who was travelling also as a naturalist.[1] I have referred to their halt at Teneriffe on August 9, where they stayed to take some necessary observations until the 18th (*ante*, p. 46). We are told that for some unexplained reason they were not popular on board, and would appear to have suffered some annoyances from the senior officers of the ship.[2] They cast anchor in the Bay of Rio de Janeiro on September 24, 1826. Here they were confronted with monetary difficulties, their letters of credit being negotiable only at Buenos Ayres, and d'Orbigny had to undertake the payment of 56*l.* to a German skipper on arrival in the Argentine, and to take all risks of being captured by corsairs on the way. They got away from Rio on October 14 and arrived at Montevideo in November. Here they got into serious trouble. The place was besieged by Gauchos, and the authorities were suffering from "nerves." D'Orbigny and Trion had made some barometric observations at sea, for which they were denounced by the intelligent German skipper; they were handed over to a company of negro soldiers under pretence of being escorted to the commandant, and were cast into prison, "a putrid hole full of malefactors and chained murderers." With

[1] Bull. des Sci. Nat. et de Geol., xi. (1827) p. 173. We never hear anything more of M. Trion.

[2] *Cf.* the observations of Moseley on the relations between the scientific and civilian staffs of the 'Challenger' Expedition. H. N. Moseley, "Notes of a Naturalist on the 'Challenger,'" London, 1879, Introduction, p. vii. D'Orbigny tells us of the obstacles put in his way by the officers; he says :—" Je regrette d'avoir à dire que j'eus beaucoup à souffrir pendant toute cette traversée du manque absolu de procédés du commandant et de son lieutenant qui ont poussé la mauvaise volonté jusqu'à contraver continuellement mes explorations." The rest of the staff seem to have behaved well.

great difficulty and much bribery they at last succeeded in communicating with their Consul and were set at liberty. This was in January, 1827, during which month they reached Buenos Ayres.

It would be far beyond the scope of the present work to attempt to give any general account, however condensed, of the events of this memorable journey or of its broad results. Von Humboldt had explored the Orinoco, and Castelnau the Amazon; d'Orbigny followed the course of the Parana, up to Corrientes and on to Barranqueras, in a native boat, in momentary danger of wreck, and of being devoured by jaguars. An added peril was that of falling into the hands of the notorious and infamous Dr. Francia, Dictator of Paraguay, who refused to allow strangers in his country. Von Humboldt's companion, the friend of the d'Orbigny family, Bonpland, had been caught by him and imprisoned, in spite of all protests from the Courts of Europe, for six years. The career of a "Naturaliste-voyageur" was not, in these times, devoid of possible incident.

Apart from the personal interest attaching to the man himself, the autobiography of this enthusiastic young traveller is full of extraordinary charm. · The natural history collections which he made fill one with amazement, when we reflect upon the difficulties of transport which he must have experienced; we are told of 4000 species of insects, 150 crustacea, 150 fishes, 600 mollusca, 100 reptiles, of which a very large number were new to science.[1] He made careful studies of geographical distribution, and most minute observations upon the life-histories and habits of the creatures which he watched during nearly seven years. He founded a complete theory of the stratigraphical geology of the South American continent, and collected palæontological specimens in illustration thereof, and we see here the basis of his remarkable views on the Cosmogony and his theory of successive Creations, establishing the relationship between the geological formations of the Old and New Worlds.

He made a careful study of the native races, and contributed to anthropology a complete treatise upon American Man,[2] besides several isolated papers. He verified Buffon's law of distribution, he mapped the districts that he traversed, and completed the geographical studies of Pentland, and introduced important corrections into the existing maps of South America. Of Bolivia he constructed not only a geographical but also a geological map.

[1] The biographer in Larousse gives us as the results of the voyage: 160 mammals, 860 birds, 115 reptiles, 166 fish, 980 mollusca and zoophytes, 5000 insects and crustacea, and 3000 plants, in addition to extensive geological, palæontological, and ethnological collections.

[2] Besides the important section on this subject forming part of vol. iv. of the larger work (1839), he published a work in two volumes entitled "L'homme Américain (de l'Amerique Méridionale) considéré sous ses rapports physiologiques et moraux," Paris–Strasburg, 1839.

In Peru he became in turn an ardent antiquary and studied the relics of the ancient civilizations, in the cradles of the Inca race.[1] He visited the ancient Missions founded by the Jesuits beyond the Cordillera in the eighteenth century, a romantic account of which is given by Labonnefon. He spent eight months in Patagonia and took part in the siege of Carmen, which enabled him to correct many wild impressions that had been rife concerning the Patagonian race. He lived among the Guarayo Indians, and brought back with him as an anthropological specimen a boy of the tribe, whom he "traded" with his grandfather for a scythe, a hatchet, and a knife. But we can no longer occupy ourselves even with these cursory observations upon this remarkable voyage. Accompanied by the mule train which bore his vast collections, he regained the western coast and embarked on board the 'Philanthrope' for Europe on July 3, and left South America on September 3, 1833. The "philanthropic" captain charged him 100*l*. for his passage home. He visited several districts on the way — Islay, Callao, Lima and Valparaiso, which he left on October 3, rounding Cape Horn, and landed in France on February 2, 1834.[2] The six years had not passed by without being punctuated by occasional severe attacks of home-sickness, and of these attacks he has left us some touching and lyrical expressions. The return to France, when "the lighthouse of Cordouan announced the Mouth of the Gironde," made amends for all. "All my past sufferings," he says, "were forgotten. I was about to see my family once more. . . . A new existence was dawning for me." He never spoke a truer word. He came to grips at once with the world of men, he embarked forthwith upon the vast mass of work which occupied his life; he began a life-long series of dissensions and disputes, inevitable to the career of so bold and obstinate an innovator, and so unsparing a critic; he entered in a word upon a life strewn with many disappointments and disillusionments, which was to end at the early age of fifty-five. In the following year the Société Géologique de France awarded him their Grand Prix, the Médaille d'Or, of the Society.

I do not think an apology is needed for having so long delayed the consideration of that branch of his work which has the more peculiar interest for us—the Memoir upon the Foraminifera of South America. The account of the voyage was, as we have seen, published by the Government on the recommendation of the Académie des Sciences, and was dedicated to King Louis-Philippe. Section V, on the Foraminifera, consists of 85 pp. and nine most beautiful plates, in large folio; it is fortunately the most accessible of all d'Orbigny's works on the group.

[1] He even named a Foraminifer *Rosalina inca*.

[2] A map of South America with the whole of d'Orbigny's journey traced upon it is given by Labonnefon (XXII., p. 9), giving all the dates of his Stations.

In this work he first recognizes Lagena (*ante*, p. 45) under the generic name of Oolina, which he introduces with the remarkable statement that having only hitherto known two genera of Monostègues he now "admits a third which our researches have brought to light in the sands of South America" (!). He explains that these little bodies had long been known to him, but finding them always associated with Nodosaria and Dentalina he had taken them to be primordial chambers of these genera. The finding of them in great numbers in material from the Iles Malouines (the Falkland Islands), where he had found no Nodosaria or Dentalina, he was obliged to recognize them as a distinct genus, since when he had found them in nearly all sands.[1] He records ten species from South America.

The Memoir suffers from d'Orbigny's tendency to give a new specific name to any species that he finds in a new locality, and thus of the eighty-one species recorded in the Memoir there are only three that are not described as new to science, of which only one has anything like a synonymy—*Globigerina bulloides*, in which he refers to the "Tableau Méthodique" again merely as a "Prodrome." His South American specific names are consequently a feature of the work—peruviana (3 spp.), patagonica (4 spp.), araucana (2 spp.), inca (2 spp.), boliviana. He collected sands from all the littorals at which he touched, captains of merchantmen supplied him with material from Payta, Acapulco, and Guayaquil, and on his return journey he obtained a sounding "made at a great depth" (160 m.) in sight of land, with a lead only a few centimetres in diameter, upon which he found a "a very fair number of Polyzoa and Foraminifera." This sounding he took as a point of departure for two distinct Foraminiferal faunas, characterizing respectively the Atlantic and the Pacific coasts of South America. He found the world-wide *Globigerina bulloides* on both sides, but otherwise fifty-two were found exclusively in the Atlantic, and thirty exclusively on the Pacific coasts.[2] In the small sounding off Cape Horn four were Atlantic forms, and he concludes that this fauna is carried north-eastwards by the currents. He makes some curious and ingenious deductions herefrom upon the distribution of Foraminifera in all latitudes and at all temperatures under favourable circumstances.[3] He makes a further analysis which

[1] It must be remembered that in 1826 he records having received sands from these islands from MM. Quoy, Gaimard, and Gaudichaud (I., p. 250; IX., p. 33), collected upon Freycinet's voyage round the world, and a paper on the zoology of the islands by Garnot appeared (with the "Tableau Méthodique") in vol. vii. of the Ann. Sci. Nat. (p. 39).

[2] He gives a complete analytical table of these on pp. 10, 11.

[3] He calls attention here to a rich gathering from the North Cape, sent to him by Mons. Robert—after whom he named the genus Robertina (a sub-genus of Bulimina), which, however, he did not retain. See Appendices E, F. See also IX., p. 17.

appears to contradict or modify his previous distribution,[1] but the principle remains the same, and Fischer points out that his deductions were subsequently confirmed by many English zoologists.[2]

This Memoir emphasizes d'Orbigny's worst fault, which is that of making broad generalizations from insufficient material. Thus he founded in this Memoir the genus Bolivina (of which he records three species) as the only representative of the Textulariidæ; not only are many Textularian species of frequent occurrence in these latitudes, but he should have been familiar with the genus Bolivina from his earliest years. It is common at La Rochelle, and must have occurred in his Cuban and Canary Islands material.[3]

X.—The Paris Chalk Memoir.

This Memoir, probably written early in 1839, and read before the Société Géologique de France on December 2 in that year,[4] was d'Orbigny's first contribution to the literature of the fossil Foraminifera. It was probably written before the three Memoirs above noticed, though he says (see *ante*, p. 43) that they are in course of publication; he mentions in connexion with three species that he had found allied forms in the Canaries, but otherwise he does not refer to the Memoirs.[5] Indeed, he says that since the publication of the "Tableau Méthodique" no living species had been described,[6] and only a very few fossil species until the appearance of Roemer's paper on the Tertiary Foraminifera of Germany in the previous year.[7]

The Memoir under review is to some extent a comparative essay on the Cretaceous of several localities; besides that from the Paris Basin, he had studied the Chalk Foraminifera of the Loire, the Gironde, of Southern France, and of Belgium, and he gives

[1] IX., p. 15. [2] XXI., p. 438.

[3] See Appendix F, note 1, p. 98.

[4] "Mémoire sur les Foraminifères de la Craie Blanche du Bassin de Paris," Mem. Soc. Geol., France, iv. (1840), pp. 1-51, pls. i.-iv. An anonymous writer in "Science Gossip" in 1870 gave an abstract of this Memoir in which all the figures are reproduced the same size as the originals, pp. 81-83, figs. 75-94; pp. 106-108, figs. 103-119; pp. 155-157, figs. 138-156.

[5] Of course it must be borne in mind that d'Orbigny would never have admitted that a recent and a fossil species could be identical (see p. 17).

[6] On this occasion he does appear to have ignored Dujardin's observations.

[7] Here, again, is one of the instances in which d'Orbigny confused dates, caused no doubt by adding notes and passages while his work was going through the press. He gives as the date of Roemer's paper 1839, referring of course to his "Cephalopoden des Norddeutschen tertiären Meeressandes," Neues Jahrb. f. Min., etc. (1838), pp. 381-394, pl. iii. (Stuttgart).

a list of localities where fossil Foraminifera are to be found.[1] Until this moment the only species recorded from the Paris Basin were *Lenticulina rotulata* and *Lituola nautiloidea* and *difformis*, described by Lamarck,[2] and copied by Parkinson,[3] Bowdich,[4] and Defrance.[5] D'Orbigny says he might have published this Memoir two years earlier, but that he wished to render the work more complete, and had, to that end, examined the Chalk and strata of Meudon, St. Germain, and Sens, of the banks of the Seine as far as the Departments of Yonne and Aube, to which were added Chalk from Cipley received from d'Archiac, and from Fauquemart received from "M. Dumont," resulting in a record of fifty-four species of Foraminifera. It is here that we see the first signs of his pet theory of Foraminifera as zone determinants, to which he was passionately attached to the end of his life, and he applies his theory in a table to the whole of the strata examined by him, arriving thereby at conclusions identical with those of d'Archiac.

With the exception of *Cristellaria rotulata* (*supra* and note 2) and *Lituola nautiloidea*, to which synonymies are attached, the whole of the species in this Memoir are described as new to science. He renames his *Rotalina truncatulinoides* (Canary Islands) *Rotalina micheliniana*, claiming that the Paris species differs in the absence of an umbilicus and of raised sutural lines on the superior surface. As we have seen (*ante*, p. 18), these two are now regarded as synonymous.

XI.—The Vienna Memoir.

Like the Cuba Memoir, d'Orbigny's "Foraminifères Fossiles du Bassin Tertiaire de Vienne"[6] is a work complete in itself, embracing in its scope the whole Order of the Foraminifera, whether recorded from the Vienna material or not, and bearing the same relation to the fossil forms as the Cuba Memoir bears to the recent. I think there is little doubt that by the time this was

[1] He tells us (p. 3, note) that von Hauer is sending him fossil Foraminifera from Transylvania and Vienna, and Lyell from the Crag of England.

[2] "Mémoire sur les Fossiles des Environs de Paris," Paris, 1802–1806. As to the former species d'Orbigny claimed it as his, on the principle referred to *ante* (p. 45), making it *Cristellaria rotulata* d'Orbigny, instead of (Lamarck).

[3] "Organic Remains of a Former World." London, 1804–11, iii., figs. 4–7.

[4] "Elements of Conchology." Paris, 1820–22, pl. 18.

[5] Defrance, Dict. Sci. Nat. Articles *Lituole* and *Lenticuline*.

[6] "Foraminifères Fossiles du Bassin Tertiaire de Vienne (Autriche) découverts par Son Excellence le Chevalier Joseph de Hauer . . . et décrits par Alcide d'Orbigny. Ouvrage publié sous les auspices de Sa Majesté l'Empereur d'Autriche," Paris, 1846, pp. 312, pls. 1–21. Text in German and French. This is the first title-page upon which d'Orbigny recorded all his titles, degrees, honours, membership of Societies, Academies, etc.

published, d'Orbigny, plunged as he was in the execution of projects of publication almost chimæric in their vastness, had realized that his "grand ouvrage" was destined to remain for ever in the limbo of unwritten books—that vast and shadowy library situated on the road to the nether-world, whose shelves are filled with phantom volumes announced for publication by ambitious authors, but suppressed by the inexorable censor, Time. Not only did he give diagnoses of all the genera named in his table, both recent and fossil, but he even added a crowded plate, containing fifty-eight figures of "all the genera which have *not* yet been discovered fossil in the Vienna Basin," and he tells us that he has considered it necessary to reproduce in this volume the general characteristics of the Foraminifera already given in his other works.[1] We find on this plate the only figures he ever published of what may be called the unique species of d'Orbigny *Rimulina glabra, Conulina conica, Robertina arctica, Cuneolina pavonia,*[2] and *Uniloculina indica.* (See Section XVI.). He gave figures in this Memoir of eight species named in the "Tableau Méthodique" which had never been figured before, besides refiguring some five and twenty species cited in the "Tableau" and from earlier authors,[3] and he also refigured ten Soldanian species from actual specimens found in the Vienna material.[4] This is the only Memoir of d'Orbigny for which he did not draw the figures himself; they were drawn and lithographed by Delarue. "They will do honour," says d'Orbigny, "to the skilful hand and great talents of observation of this distinguished artist, to whom Palæontology is indebted for such good work"; they rank certainly among the finest figures of Foraminifera ever published.

The leading theme of this Memoir is the exposition of d'Orbigny's views upon the relative distribution of the Foraminifera in geological strata and the existing oceans.[5] It would be impossible to give more than a passing glance at this portion of his work, but it is very interesting to mark the progress of palæontological knowledge by comparing it with Chapman's extended and conscientious labours in the same field.[6] As to the precise formation from which the material was obtained he hesitated to pronounce a definite opinion; Bronn had placed the beds between the London Clay and the Subapennine, and in the Miocene of Lyell[7] d'Orbigny regarded them as much more recent, but he deferred any definite pronouncement until such time as

[1] XII., pp. ix and 3, pl. xxi.
[2] Reproduced in the "Cours Elémentaire," XIV., vol. ii., p. 203, fig. 330.
[3] XX., p. 259. [4] XX., p. 260. [5] XXI., p. 436.
[6] F. Chapman, "The Foraminifera." London (Longmans), 1902.
[7] Neues Jahrb. f. Min., etc., 1837, pp. 408, 431.

he should have made a more extended study of the accompanying Mollusca.[1]

According to d'Orbigny no Foraminifera had been recorded of earlier geological age than the Upper Lias, with the exception of *Fusulina cylindrica* Fischer, from the Carboniferous;[2] a glance at Chapman's excellent Bibliography[3] marks the progress, or rather the retrogression, of knowledge on this subject. Chapman dealt with the matter at some length in a previous paper,[4] and more recently Earland and I have dealt with it in our paper "On the Foraminifera as World-Builders."[5] Out of many instances we may note that d'Orbigny says in this Memoir that no Miliolidæ have appeared in the Upper Chalk, and that Verneuilina, Gaudryina and many others "appear and disappear" with the Cretaceous. His summary of geological distribution is not uninteresting; he gives us the following distribution: Carboniferous 1 species, Jurassic 20, Cretaceous 280, Tertiary 450, Recent 1000. His table of distribution of the latter is no less didactic and empirical; he gives us: Warm water regions 575, temperate 350, cold 75.[6]

As in the Cuba Memoir and elsewhere, d'Orbigny reviews the work of previous authors and awards the palm, not without some reason, to Fichtel and Moll, whose work he pronounces as far superior to much that was then being published on the Foraminifera.[7] This hits at the contemporary work of Ehrenberg, Reuss, Roemer, Geinitz, Neugeboren, and others. Indeed, in a note (on p. xxxi) he stigmatizes the work of Ehrenberg as practically useless (again with reason), on the ground that he determined his species by transmitted light, saying justly that "it is only by reflected light (*opacité*) that one can arrive at a true comprehension of the forms, and the exterior details of the genera and species." At the same time he deplores the unsatisfactory and incomplete figures of Geinitz, Roemer, and Reuss, from which, as he justly observed, it is impossible to recognize species of which one possesses examples.[8] Fichtel and Moll worked upon material

[1] Eduard Suess, in his Memoir, "Untersuchungen ueber den Charakter der öesterreichische Tertiärablagerungen" (1866), gave a clear exposition of this somewhat complicated area, from which it would appear that the Eocene is overlaid by marls and shales, and are followed in the Vienna Basin by the lowest Miocene, above which is the Marine series—the "Tegel" of d'Orbigny, which is highly fossiliferous, and from which it is fairly certain that the majority of the Vienna Foraminifera were derived. See also XXV., p. 531.

[2] XII., p. xxv.

[3] Op. cit., p. 335, *et seq.*

[4] In "Foraminifera from an Upper Cambrian Horizon in the Malverns," Q. J. Geol. Soc., lvi. (1900), pp. 257–263, pl. xv.

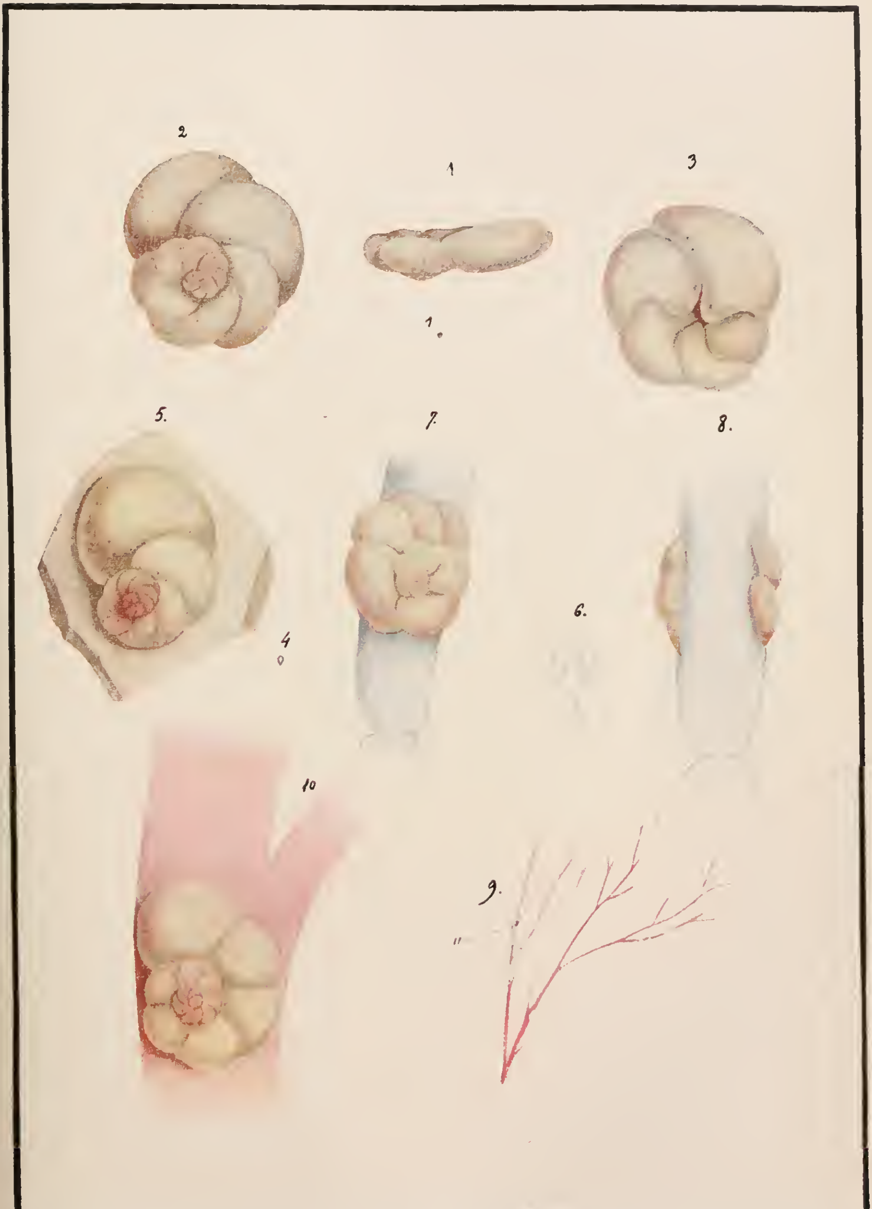
[5] Journ. Quekett Micr. Club, ser. 2, xii. (1913), pp. 1–16, pls. i.–iii.

[6] XII., pp. xxxiii and xxxvii.

[7] XII., p. vii.

[8] The splendid series of Memoirs upon which Reuss's fame rests only began in this year with his "Versteinerungen der böhmischen Kreideformation" (Stuttgart, 1845–6). His earlier paper in Geinitz' "Grundriss der Versteinerungenskunde," of the same date, deserves all that d'Orbigny says of it.

Rosaline *Rosalina* d'Orb.



1–10. globularis variétés N°1.

Plate VIII. Reduced ($\frac{1}{2}$) facsimile of the Planche inédite of *Rosalina (Discorbina) globularis.*

from the Mediterranean, the Adriatic, the Red Sea, and some fossils from Sienna and Austria; they were themselves Austrians, and we may forgive d'Orbigny for flattering them a little as being compatriots of von Hauer.

The material for the Vienna Memoir came from many localities in the neighbourhood of Vienna and Baden. As we have seen (*ante*, pp. 45, 54), von Hauer was in communication with d'Orbigny on the subject in 1838, and d'Orbigny had sent him a preliminary report, which von Hauer published in 1839.[1] Since that time von Hauer had extended his collections and pursued his researches, and by 1844 had collected "the richest Foraminiferal fauna ever met with in any country,"[2] and wrote asking d'Orbigny to compose a special work upon them. Being then, as he points out, fully occupied with his "Paléontologie Française" and his "Amérique Méridionale," he hesitated to undertake the task, but fearing that the results of these valuable labours might be lost to science he finally determined to embark upon it, in spite of the numerous sacrifices which it entailed upon him, encouraged thereto by the patronage of the Emperor of Austria, who undertook to defray all the expenses of publication and illustration. The work occupied him for two years, and he signed the Introduction on July 30, 1846. He separated and recorded 228 species, a larger number, he says, than are to be found in any existing ocean—another of those sweeping generalities to which d'Orbigny was so much addicted.

As might be expected when dealing with fossil forms, he makes a new species of practically everything, and claims as his own any species which he removes into another genus, but the synonymies in this work are fuller than any he has attempted before, and when he claims a species in this manner the original author is given.[3]

[1] J. von Hauer, "Mittheilung an Prof. Bronn gerichtet, Bestimmung der Wiener Foraminiferen durch d'Orbigny, und Entomostraceen von dort," Neues Jahrb. f. Min., etc. (Stuttgart, 1839), pp. 428–9. This communication, which is dated February 18, 1839, was accompanied by a set of duplicates—so far as he had duplicates—of the species von Hauer had sent to d'Orbigny, with a complete list of names as determined by him. The specimens were all from Nussdorf, and numbered seventy-four. The letter is followed (p. 430) by another from von Roemer, to whom Bronn appears to have sent the specimens and list (at von Hauer's request) for the purpose of comparing them with his "Cephalopoden," described the previous year from the North German Tertiary Marine Sand (Neues Jahrb. f. Min., etc. (1838), pp. 381–394, pl. iii.), and to check the nomenclature (!) Roemer tells us that he possessed a collection of 300 species, and on comparing the Vienna species with his own, he disagrees with the nomenclature of nine out of thirteen species common to both collections. It need not, therefore, surprise us to find that d'Orbigny did not greatly appreciate von Roemer (see p. 56).

[2] XII., p. ix.

[3] See specially the elaborate synonymies of *Cristellaria cassis* (p. 91), *Cristellaria* (*Robulina*) *cultrata* (p. 96), and *Polystomella crispa* (p. 125), which according to his practice is ascribed to Lamarck.

XII.—The Article "Foraminifères" in the Dictionnaire Universelle d'Histoire Naturelle.

Carpenter is not quite accurate when he says[1] that d'Orbigny "altogether abandoned the notion of the Cephalopod affinities of the group" in this article in the year 1844, assigning them a place among the Radiata of Cuvier between the Echinodermata and the Polyzoa, and repeats the account verbatim in the Vienna Memoir. This article was published in 1844,[2] and is practically a condensation of the Introductory portion of the Vienna Memoir, which was written at the same time, and to which he refers the reader, the only innovation being the introduction of the genus Amphorina (see Appendix F., note 2). Nor is it true that he accepted Dujardin's account of the group "without the least reference to the real discoverer of its Rhizopodal character." In the very article which Carpenter thus holds up to scorn, d'Orbigny refers to the "revolution" introduced by Dujardin as "observations which, as I have myself recognized, compel us to separate them not only from the order of the Cephalopoda, but even from the class of Mollusca, to relegate them to the lower classes of animals, in which I think they must remain for the future;"[3] and in 1839 in the Cuba Memoir he had recognized Dujardin's work, as we have seen. There is nothing in this article of importance which is not in the Vienna Memoir, but he slightly modifies the figures in his Tables of Distribution, both recent and fossil, giving totals of 1631 fossil, and 900 recent. It is only of interest as being virtually the last special contribution of d'Orbigny to the literature of the Foraminifera. It is marred by his curious comparison of the pseudopodia of the Foraminifera to the ambulacral processes of the Echinoderms. We may assume that this article and the Vienna Memoir were synchronous, but that this article was written either after the Introduction to the Vienna Memoir had been drafted, or as a "Prolegomena" to that work.

[1] XVII., pp. 7, 8.

[2] The date of the publication of this article is of importance to us, and the work having been issued in the popular French form of "livraisons" some confusion has arisen in bibliographic references to its volumes. Messrs. C. D. Sherborn and T. S. Palmer have devoted one of their remarkable bibliographical notes to the work (Ann. and Mag. Nat. Hist., ser. 7, iii. (1899), p. 350), from which we can date this article with certainty as above. The title-pages of the available copies are dated 1844, 1848, 1849, and 1861, the earliest date being probably, as Sherborn suggests, a misprint (?) for 1845. The actual date of the publication of the completed volume was January, 1845, as announced in the Bull. Soc. Geol. France. Livraisons Nos. 49–54 were announced November 4, 1844; No. 55, November 18, 1844; No. 56, December 16, 1844; Nos. 57, 58, January 6, 1845. The "Nouvelle Edition" of 1861 (often not dated), like the editions of 1848 and 1849, is merely a re-issue of the original volumes with new title-pages.

[3] XIII., p. 663.

XIII.—The "Cours Elémentaire" and the "Prodrome," 1849–52.

This is the last work of d'Orbigny with which the student of the Foraminifera has need to be concerned, and though apparently it consists of two works, it is really composed of three parts, which constitute a whole.[1] What strikes one most forcibly when studying the life and work of d'Orbigny is the enthusiasm with which he was always ready to embark upon works of vast extent—witness the "grand ouvrage" of which we have *disjecta membra* in the "Tableau Méthodique," and the Cuba and Vienna Memoirs, and others to which I shall have occasion to refer. As Fischer says, "Les grands travaux exercaient sur lui une véritable séduction."[2] As soon as he had got the publication of his "Voyage dans l'Amérique Méridionale" into full swing he devoted the rest of his life to Palæontology,[3] especially that of the lower zoological orders. No collection of fossil Invertebrata existed in France, and he set himself to work to form one; we have seen something of his methods (p. 18), and such was his success that the collection he made, which was acquired by the State after his death (in 1858) for 50,000 francs, numbers more than 100,000 specimens. Armed with this collection as it grew, he undertook the "Paléontologie Française," which took from 1840 practically to the date of his death (1857) to publish, and which was twice awarded the Wollaston Fund by the Geological Society of London.[4] Among the 3000 species recorded therein 2500 were described for the first time by d'Orbigny.[5] Fischer records the sensation which it produced in the scientific world.[6] Before his death d'Orbigny superintended the publication of eight volumes, illustrated by 1000 plates, of this gigantic work, and after his death the Société Géologique resolved to continue it. Cotteau, Loriol, Deslongchamps, Piette, and Fromental added special portions, but finally it had to be abandoned in its turn for lack both of the means and of scientific workers.[7] Nevertheless, Fischer says of it, "One may say, without fear of contradiction, that most provincial geologists are pupils

[1] (1) "Cours Elémentaire de Paléontologie et de Géologie Stratigraphiques." Paris: i., 1849; ii., 1852. (With an atlas of 17 folding pls.). (2) "Prodrome de Paléontologie Stratigraphique Universelle des Animaux Mollusques et Rayonnés faisant suite au Cours Elémentaire de Paléontologie," etc. Paris: i., 1850; ii., 1850; iii., 1852.

[2] XXI., p. 435.

[3] XVI., p. 830.

[4] According to the biography in Larousse this was awarded to him twice. It was first awarded to him in 1847, and in the following year (1848) he received one moiety of the Fund.

[5] XXII., p. 13; XVI., p. 831.

[6] XXI., pp. 441–2.

[7] XXV., pp. 508, 521.

of d'Orbigny by the daily use which they make of his work."[1] Whilst it was in progress, he conceived the vaster idea of the "Paléontologie Universelle"—as Gaudry says, "his vision needed vast horizons"[2]—and not content with this he undertook the "Histoire des Mollusques vivants et fossiles,"[3] and announced a "Cours de Paléontologie générale et appliquée." This programme, which may well be described as staggering, was, in fact, fantastic and chimerical. Perhaps fortunately for him, in the year 1844 F. J. Pictet published the first volume of his "Traité Elémentaire de Paléontologie,"[4] which alarmed d'Orbigny's publishers, and the "Cours de Paléontologie Générale" (which was partly in print) was abandoned, and the "Cours Elémentaire" was substituted for it. The publication of the "Paléontologie Universelle des Coquilles et des Mollusques" was started in 1845, and d'Orbigny was extremely annoyed when Quenstedt in a review stated that it was impossible for a single man to undertake so vast a work. However, several parts were published when the upheaval caused by the Revolution of 1848 put a stop to this also. His catalogue of species, however, was practically complete, and as the "Prodrome" it became welded with the "Cours Elémentaire" in the manner with which we are familiar.[5] The "Prodrome" in its familiar form contains over 18,000 species arranged in stratigraphical order (see *infra*, pp. 61, 62), and giving 40,000 names in the synonymies.[6]

[1] XXI., p. 441. D'Orbigny's "Paléontologie Française" and its fate may be compared with Goldfuss and Munster's "Petrefacta Germaniæ," which was similarly designed to describe and illustrate all the fossil Invertebrata of Germany, but it had to be abandoned when the Sponges, Corals, Crinoids, Echinoderms, and a small part of the Mollusca had been dealt with. Three large folio volumes were published at Dusseldorf between 1822 and 1844, of which a second edition was issued at Leipzig from 1862–66.

[2] XVI., p. 833.

[3] Of this work, from the first volume of which, published in 1845, I have gathered a few facts (Bibl. XI.), only a small portion was issued. The first volume consisted of 240 pages, and was illustrated by sixteen lithographic plates exquisitely drawn and coloured by hand. The final form was a volume containing these pages and a further 365, making a single volume of 605 pages, which takes the Mollusca down to the end of the Cephalopoda. He tells us (on p. 9) that he was writing upon a basis of over 70,000 notes gathered from the works of previous authors, besides his own collections of actual specimens.

[4] F. J. Pictet: vol. i., 1844; ii., 1845; iii., 1846; iv., 1846. In vol. iv. (p. 213) Foraminifera appear as Class ii. of the "Zoophytes ou Rayonnés," in the second edition, 1853–57 (iv., p. 482), as Class iv. of the same.

[5] XVI., p. 833; XXII., p. 14; XV., pp. ix, xi.

[6] It must, of course, be borne in mind that d'Orbigny's theories of classification led to a bewildering multiplication of species. The Polyzoan *Flustra pilosa* Linné is placed in four distinct genera according to its locus of attachment. See on this and other instances XXI., p. 443. He fell into—or rather clung to—the same error of classification by external appearance in his works on the Sponges (see XXV., pp. 387 and 397). His work on the Bryozoa in the "Paléontologie Française," in which he described and illustrated 319 genera and 1929 species, is so marred by this defect that it was to all intents and purposes ignored by MacCoy, Hagenow, and Haime in their later and more authoritative works on the group.

He accomplished in fact the ambition of Buffon, and took up the legacy of work which that savant bequeathed to posterity.[1]

We must consider the volumes which form the subject-heading of this section in the order of their date, but the three issues are inseparably connected. The "Prodrome" was published between vols. i. and ii. of the "Cours Elémentaire"; it was announced as "appearing in a few months" in vol. i. (p. 259, note), and as containing all the evidence upon which his generalizations of all sorts were founded. He tells us it was finished in 1847, but, as in the case of the "Cours de Paléontologie Générale," its publication, which he expected to take place in 1848, was delayed by the Revolution of that year, and it could not appear before 1849. Vol. i. is dated 1850. This accounts for the date 1847 appended to a great number of the species enumerated.[2] It had taken him fourteen years to compose, and was the outcome of more than 200,000 references and evidences.[3] He says himself that "the 'Cours Elémentaire' contains the 'conclusions,' the 'Prodrome' the evidence. They are two works which are really one; a whole divided into several parts."[4] The "Prodrome" is quoted as a published work in the first pages of vol. ii. of the "Cours Elémentaire." The two together set forth the scientific doctrine of d'Orbigny,[5] and he says himself, in the Introduction to the "Prodrome," that it is his "profession of faith" (pp. xxxiii and xlix). I have pointed out the factors which led to his institution of a vast number of species, and in the same year that saw the publication of the "Prodrome" he tells us himself [6] that 24,000 distinct species of fossils are known to him.

The text elaborated by d'Orbigny in these volumes is that the name and nature of a fossil are of secondary importance compared

[1] Buffon, Hist. Nat., Section "Minéraux," 1st ed. 1783-8, vol. iv. (1786) p. 157. "C'est surtout dans les coquillages et les poissons, premiers habitants du globe que l'on peut compter un plus grand nombre d'espèces qui ne subsistent plus; nous n'entreprendrons pas d'en donner ici l'énumération . . . ce travail sur la vieille nature exigerait seul plus de temps qu'il ne m'en reste à vivre, et je ne puis que la recommander à la posterité." Von Zittel states, however, that d'Orbigny's "Prodrome" was less complete than Bronn's Index Paleontologica (XXV., p. 365).

[2] XV., p. lix. D'Orbigny pursued a practice in several of his works, which has been condemned by all naturalists, of appending to his species a MS. date of this kind. It is of course universally accepted that a species must date from the time of its publication, a principle which d'Orbigny himself insisted upon in his various writings upon nomenclature (see p. 65).

[3] Fischer commenting upon these figures in 1878 points out that in 1868 Bigsby (Thesaurus Siluricus, London, 1868) had enumerated 8,897 species from the Silurian alone, and that it was probable that by the end of the nineteenth century more than 100,000 would have been enumerated (XXI., p. 444).

[4] XV., p. lvii.

[5] XXI., p. 443.

[6] "Recherches zoologiques sur la marche successive de l'animalization à la surface du globe, depuis les temps zoologiques les plus anciens jusqu'à l'époque actuelle," Comptes Rendus, Ac. Sci., xxx., 1850.

to its age.[1] Von Zittel, in his admirable review of d'Orbigny's work,[2] states the foundation of his theory:—"He divided fossiliferous rocks into six periods (*terrains*), and subdivided the first five periods into twenty-seven groups (*étages*). He selected the names of characteristic localities for the designation of the groups of zones, and followed Thurmann's example in adding the affix '*ien*' to give uniformity to the series." We have referred (*ante*, p. 17) to his fundamental theory that each stratum was the result of a special renewed act of creation, a theory whose principal apologist was Gaudry, who appears to agree with d'Orbigny that there is nothing fantastic in the idea that an anthropomorphic Deity had twenty-six times intervened in the development of the universe, destroying all previously created beings by great catastrophal convulsions and starting entirely afresh with a new series of creatures.[3] "It was in this manner of grouping creatures and of considering Palæontology that the originality of d'Orbigny is found," says Fischer;[4] "he affirmed that a number of times all the species of animals had disappeared to give place to new forms. In each of his zones he noted the appearance, the extinction of orders, of families, and of species. In a word he established the doctrine of successive creations." It is not necessary in this place to deal with this fundamental error; the successive criticisms of Barrande, of Darwin, of Philippi, of Deshayes, of Archiac, and a host of other writers have annihilated the d'Orbignyan theory, whilst rendering just tribute to the great services which d'Orbigny rendered to Palæontology founded upon that theory. The theory after all originated with Cuvier, whose views he elaborated, and Élie de Beaumont supported him.[5] "No doubt," says Gaudry, "the first glory of this idea belonged to Cuvier and to Brongniart; in France, in Germany, and especially in England, many geologists have developed it; but no one fought for it more strenuously than d'Orbigny, and no one has worked harder to promulgate it;"[6] and in a later passage (p. 846), "if we compare the Palæontology of to-day with what it was in the days of Cuvier and Brongniart, its original founders, one sees what immense progress it has made, and everyone must admit that d'Orbigny was one of those who

[1] XXI., p. 445. He illustrates his text by pointing out as a *reductio ad absurdum* that if this course is not adopted a historian noting the likeness between Napoleon I. and some of the Roman Emperors might assign Napoleon to the Capitol, and those Roman Emperors to the Tuileries (XV., pp. xv and xxv). But this was a somewhat two-edged argument in the face of his own classification of the Foraminifera and other groups (Bryozoa, Sponges) by external appearances only.

[2] XXV., p. 507. [3] XVI., pp. 835, 838, 841. [4] XXI., p. 445.

[5] As Prof. Marcellin Boule has put it, "The ideas of d'Orbigny are in some respects a continuation of those of Cuvier. With the geologist Élie de Beaumont, he took up and exaggerated the theory of cataclysms." See "La Paléontologie au Muséum et l'Œuvre de M. Albert Gaudry," Revue Scientifique, May 28, 1904.

[6] XVI., p. 837.

gave to it its strongest impulsion."[1] It must be remembered also that Agassiz in 1845 wrote a monograph in which he questioned the conclusions of Philippi and his school, and reached others which find a remarkable parallel in those of d'Orbigny. It is here that we find the early history of the contest between the Uniformitarian and the Catastrophal theories.[2] It followed naturally that d'Orbigny and his followers regarded the creation of man as Catastrophal: "for his privileged creature God could arrest the ordinary course of Nature."[3] To adopt the terminology of a more recent date, d'Orbigny, Élie de Beaumont, and Gaudry (though to a lesser degree) were whole-souled Vitalists.

It follows from this that d'Orbigny attached the highest importance to fossils as zone-determinants. As von Zittel points out: "d'Orbigny thought it possible to base stratigraphy wholly upon palæontological features, more especially upon the occurrence of Mollusca, Echinodermata, and Cœlenterata"[4]—he might have added, and of Foraminifera. This makes its first appearance in the Paris Chalk Memoir, where he lays down an axiom that found its echo and reiteration in all his later works:—"The comparative study of the fossil Foraminifera of all zones has proved to me a fact of geological importance: it is that each zone has its characteristic species, by which it may be recognized in whatever circumstances that can occur; and these little shells being infinitely more common than those of Mollusca, the application of them which we can make is so much the more certain and becomes extremely interesting."[5] He elaborates this theory at great length in the Vienna Memoir,[6] in the "Prodrome,"[7] and in the "Dictionnaire Universelle."[8] The most direct contradiction of the theory comes, as we might expect, from Carpenter, who, after reviewing shortly the geological record, observes:—"No other group affords anything like the same evidence, on the one hand, of the derivation of a multitude of distinguishable forms from a few primitive types, and, on the other, of the continuity of

[1] Gaudry's views upon evolution were based upon an erroneous premise. He argued that the Sponges and Foraminifera are the most elementary of the Radiata, the Echinoderms the most developed, and that therefore the Echinoderms must have developed later than the Sponges and the Foraminifera, and he states the erroneous postulate that the Echinoderms are more numerous in the early geological ages than the Sponges and Foraminifera (XVI., p. 839). This of course is not the case. But, as Gaudry points out (p. 847), Palæontology was at the time when he wrote only a study of the last fifty years.

[2] For a reasoned discussion of the principles involved see XXV., pp. 197, 379.

[3] XVI., pp. 838, 847.

[4] XXV., p. 507. *Cf.* Gaudry writing in 1858, "The more d'Orbigny's ideas gain ground, the more we shall believe that the fossils, strictly confined in certain strata, serve as means of recognition not only of the principal groups of the periods, but also of their sub-divisions—and the more also will palæontology gain in importance."

[5] X., p. 4.

[6] XII., p. xxiii *et seq.*

[7] XV., pp. xxxix *et seq.*

[8] XIII., p. 670.

those types through a vast succession of geological epochs." But Carpenter was to some extent at fault here, for, as we have shown in another place, the earliest recorded Foraminifera were of types which are far from primitive.[1]

It must be admitted that d'Orbigny arms his opponents with a powerful argument in the course of his passionate plea for the necessity of combining zoological with palæontological knowledge, and both with geology. He points out that the palæontologists and geologists, ignorant of each other's special branch of science, have given to the same form many different names, both generic and specific[2]—a two-edged argument, such as may be often found scattered through his works. At the same time, it must be conceded that he did not spare his own faults whilst criticizing those of others;[3] in the "Prodrome" he remarks with some quaintness, "I have revised my own works with the more severity, as I was not afraid of offending the author, whom I am far from regarding as infallible."[4] D'Orbigny's plea was far from acceptable to a certain section of contemporary geologists. On the publication of the first volume of the "Paléontologie Française," in which it was voiced, Constant Prévost made himself their spokesman; he wrote in 1845: "I protest against the daily growing abuse of the application of Palæontology to Geology."[5] But Fischer tells us that the d'Orbignyan school was in no way discouraged by these fulminations.[6] D'Orbigny prided himself on his patience under criticism, and states his aversion to scientific polemics; but this was after he had devoted twelve pages to a fairly pungent reply to the criticisms of Quenstedt,[7] to which he returned with some force, later.

It follows from what has gone before that d'Orbigny's nomenclature is frequently terrifying in its vastness of ramification. The system upon which he proceeded is set forth at great length in the "Prodrome,"[8] and is practically that adopted by the Inter-

[1] Heron-Allen and Earland, in Journn. Quekett Micr. Club, ser. 2, xii. (1913), p. 3 (see also p. 72 *infra*).

[2] XV., pp. xi, xii.

[3] *Cf.* the corrections and the suppressions contained in the Cuba Memoir, to which he especially refers, saying: "I set more store upon perfecting my method, and on wiping out the errors that I may have made, than upon the conceit of preserving my earlier work intact" (VII., p. 36). Thus he made subgenera of Dendritina and Spirolina (Ibid. pp. 58, 62).

[4] XV., p. lvi. I have referred (*ante*, p. 17) to the multiplication of species brought about by his theory of successive creations.

[5] Bull. Soc. Geol. France, ser. 2, ii., p. 374. See also Fischer, *post*, p. 69.

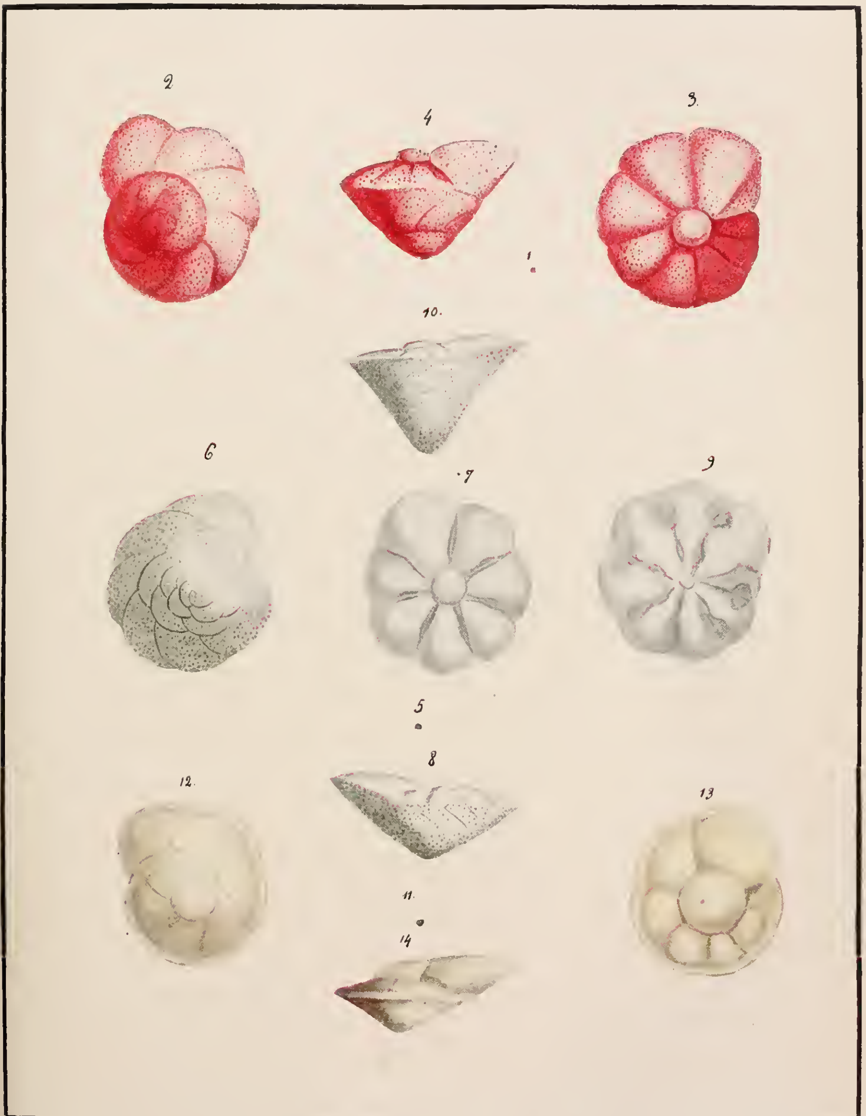
[6] *Cf.* his return to this subject in XI., pp. 8, 9, where he deals with the necessity of zoological knowledge in classifying the fossil Mollusca.

[7] XV., pp. xii, xx, xxii, xxvii. D'Orbigny appears to have been the first seriously to criticize Quenstedt's obstinate restriction of his views to what he could learn from the Jurassic of Wurtemberg, without comparing his observations with those of any other authors. Quenstedt's compatriot Von Zittel entirely endorsed d'Orbigny's strictures (XXV., p. 506).

[8] XV., pp. xxxviii *et seq.*, xlvi, l *et seq.* This is an elaboration of the principles which he laid down in the "Mollusques vivants et fossiles" in 1845. See XI., pp. 103 *et seq.*

Rotalie *Rotalia* Lam.

S: G Rotalia.



1 – 4 rosea n. 7
5 – 10 squammosa n 8
11 – 14 · marginata n. 9

Plate IX. Reduced ($\frac{1}{2}$) facsimile of the Planche inédite of "Rotalia."
Figs. 1—4, *Discorbina rosea*; 5—10, *Cymbalopora poeyi*;
11—14, *Rotalia marginata*; *nom. nud.*

national Congress Committee, save for the habit to which I have referred of claiming the authorship of species which he had removed to other genera. In the "Prodrome" he cites 668 species of Foraminifera, besides twenty-six species not named, but noted under their genera in his 19th Étage (Albien).[1] Many of these species have disappeared as completely as those of the "Tableau Méthodique," either from being never heard of again, or from being swallowed up in the synonymies of other species. The earliest recorded is *Fusulina cylindrica* Fischer (see *ante*, p. 56) from the Carboniferous (*Carboniférien*); the next—his own earliest records—from the Lias (*Liasien*), eighteen species communicated to him by Olry Terquem.[2] In the "Toarcien," with the exception of *Placopsilina scorpionis* (= Webbina), the five species are from the Vienna Memoir. His synonymies are often incomplete or misleading. For instance, in the "Bajocien" he cites *Cristellaria gibba* as new (1847), giving the first record as that of Roemer (Robulina, 1839), ignoring his own records of 1826 and 1839 on the ground that these were of recent specimens, a system of selection which, regard being had to his admitted principles of differentiation of species, is very confusing. In the "Bathonien" he claims the Alga Conodictyum as a new Foraminifer, having removed it from Conipora (d'Archiac); and Polytrema appears as a Zoophyte, though Dujardin had pointed out its Foraminiferal nature in 1835 and 1841. In the "Corallien" he cites the fossil fruit *Goniolina hexagona*; in the "Neocomien" he includes Cornuel's Planularia as his own, in the genus Vaginulina. In the "Albien," as we have seen (*supra*), he gives no specific names; in the "Cenomanien" there are a few new species cited, the rest being from Vienna; in the "Turonien" all the species are new; in the "Senonien" (Upper Chalk) the species are mostly from the Paris Memoir. In the "Parisien" we find Dactylopora removed from Polytripa (Defrance) and claimed by d'Orbigny,[3] and *Nummulites variolaria* similarly removed and claimed from Lamarck. These instances, among many others, give an idea of what is to be found in the sections devoted to Foraminifera in the "Prodrome." He had in addition a confusing habit of adding the prefixes *sub-*

[1] There is no explanation of why these species were not named, and even the numbers appended to them are eccentric. In vol. ii. of the "Cours Elémentaire" he states that he cited 657 species characteristic of their respective zones. It must be borne in mind that all the references in the "Prodrome" to the "Tableau Méthodique" (which are dated 1825) appear to be wrongly paged, for the reason that d'Orbigny did not give a reference to the original in the Ann. Sci. Nat., but to one of the reprints issued with the Models, which were re-paginated. This is perhaps one of the earliest examples of the pernicious practice of quoting pagination from a reprint instead of from the original article.

[2] XV., vol. i., p. 241. Terquem did not himself begin to publish the results of his studies of the Lias of the Moselle and elsewhere till 1858.

[3] Besides Dactylopora, we find here among the Foraminifera the false genera Acicularia and Ovulites. (See XVII., pp. 127, 137, 179.)

and *pseud-* to earlier specific names, and claiming them as new d'Orbignyan species—thus: *Textularia sub-elongata* d'Orb. for *T. elongata* Cornuel,[1] *Frondicularia pseudo-ovata* d'Orb. for *F. ovata* Phil.[2] It will be readily appreciated that any reference to the "Prodrome" in synonymies, though often justifiable and valuable, must be made with very great care. It must also be borne in mind that his new family Cyclostègues (see *ante*, p. 26) appeared and disappeared with this work.[3]

It was d'Orbigny's announced intention[4] to issue a yearly Supplement to the "Prodrome," and he begged authors of papers on the Mollusca and Radiata to give him notice of their papers to that end. No such Supplement, however, was ever issued, a failure of an intention which, however praiseworthy in itself, one cannot help being thankful was never realized.

Immediately after the publication of vol. iii. of the "Prodrome" in 1852, the second volume of the "Cours Elémentaire" made its appearance. We need not refer to any other section than that devoted to the Foraminifera (p. 189), where they are placed as the second division of the Zoophytes—"Zoophytes Globuleux." This section is mainly interesting as containing his latest expressed views upon the group. The general introduction, which is very short, is a condensation of that in the Vienna Memoir, and the text is an analysis of genera only, no species being named, excepting in the legends to the seventeen woodcuts which illustrate it. Of these, eleven are reproduced from the Vienna, one from the Paris, and one from the South American Memoirs. The figures, which are new so far as d'Orbigny's work is concerned, are:—

Fig. 316. *Orbitoides media* (this figure is repeated in part iv., p. 689, fig. 557).[5]
„ 318. *Marginulina harpula* (repeated at p. 475, fig. 427).
„ 322. *Nummulites planulata* (of which the middle figure appears to be an Anomalina).[6]
„ 323. *Nummulites nummularia*.[7]

[1] XV., vol. ii., p. 111.

[2] XV., vol. iii., p. 153. Not to multiply instances, I may refer to *Dentalina striata* d'Orb., 1826, which is ignored by Sherborn, but is claimed by d'Orbigny here (vol. iii., p. 152) as the original, and therefore the correct name of *Nodosaria acicula* (Phil., 1844). [3] See XVII., pp. 7, 105. [4] XV., p. lx.

[5] The genus Orbitoides was first instituted by d'Orbigny in 1847 for the reception of a peculiar fossil brought from the United States by Sir C. Lyell, who had noticed it (Q.J. Geol. Soc., iv., p. 12) under the name of *Nummulites mantelli* previously conferred upon it by its discoverer Morton. I have not, however, been able to discover that d'Orbigny gave any definition of the genus previously to the publication of the second volume of his "Prodrome," in which he characterizes it by a portion of the de cription which he afterwards more fully gave in his "Cours Elémentaire," ii., p. 194 (XVII., p. 298). See Appendix F., note.

[6] It might equally be taken to be identical with his *Rotalina voltziana*, of the Paris Chalk Memoir (pl. ii., fig. 33).

[7] The figures which make up the composite illustration of this species are very familiar, the vertical section having done duty in many works both before and since

The section concludes with a "Résumé géologique sur les Foraminifères." He condenses his views on geological distribution from the Vienna Memoir, as also his views on geographical distribution (*ante*, p. 56), and his statements as to the occurrence of recent forms is as generalized, and consequently incomplete, as before. The section is "illustrated" in the Atlas of "Tableaux," issued with vol. ii. in 1852, by plate 14, which gives[1] in a tabular form a "Répartition des Genres et des Espèces de Foraminifères à la surface du globe terrestre depuis le commencement de l'Animalization jusqu'à l'époque actuelle," in which the genera are set out in the order of their appearance in the geological record (beginning with Fusulina), with a series of signs denoting their appearance, disappearance, maximum, minimum, and so on.

Later in the volume he repeats his theory of successive creations for all his twenty-seven zones and their extinction *seriatim*—which, as we have not yet had occasion to remark, made its first appearance—which he announces here as a *fact*—in the "Paléontologie Française" (vol. ii., p. 423).[2] He goes so far in this place as to set down as another *fact*, that there are no intermediate links between the fauna of one zone and that of its successor—everything has been radically changed from zone to zone by Catastrophal Destruction (*anéantissement brusque*). It is noticeable also that even in this last work of his upon the Foraminifera he again ignores the genus Lagena, though he must have known of the work of Williamson, whose paper on the genus had been published in 1848,[3] and who appears in his list of correspondents in the "Prodrome." Indeed, as I close these terminal leaves of d'Orbigny's published work on the group, I am forcibly reminded of Dr. A. D. Godley's "Address by a Professor to his Lecture"—

> "Though Truth enlarge her widening range,
> And Knowledge be with Time increased,
> While Thou, my Lecture! dost not change
> The least,
> But fixed, immutable amidst
> The advent of a newer Lore
> Maintainest calmly what thou didst
> Before!"

1850 (it appeared, I think, for the first time as fig. 4 on pl. iii., in Carpenter's first paper on the Foraminifera in 1849 (see note 1, p. 71), and again in the first edition of his work on the Microscope in 1856). The other three may be original (I have not been able to locate any originals from d'Orbigny's synonymies in the "Prodrome"), but they are vastly inferior to anything d'Orbigny had ever given as an illustration before.

[1] No species are mentioned.

[2] XIV., vol. ii., pp. 251–2.

[3] W. C. Williamson, "On the Recent British Species of the Genus *Lagena*," Ann. Mag. Nat. Hist., ser. 2, i. (1848) pp. 1-20, pls. i. and ii.

XIV.—The Last Years of d'Orbigny.

The passing references to d'Orbigny's works other than those exclusively dealing with the Foraminifera have thrown many side-lights upon the occupations of his later years. It would be impossible to give any idea of the amount of work which d'Orbigny contributed to scientific literature between the date of his return from South America and his death. Fischer and von Zittel have called attention to many of his larger works, and the former has given a list of his Memoirs and completed treatises, which comprises sixty-seven titles, from which it would be easy to select half a dozen, any one of which might have constituted the life-work of any ordinary man.[1] In addition to these he contributed many articles to his brother Charles's "Dictionnaire Universelle de l'Histoire Naturelle," besides the one upon the Foraminifera which I have discussed in Section XII. As Fischer rightly observes, "one is stupefied by this incredible facility for observation and production." But it may be said that the production of the volumes of the "Paléontologie Française" was his last work, which indeed he left unfinished (see p. 59).

The concluding years of his life were not without disappointments, for no scientist who did so much, and expressed such forcible views, and suggested such striking innovations could fail to arouse the jealousies and criticisms of a certain section of his contemporaries. His work was never substantially remunerative—where is the pure scientist of whom this could be said?—and in his later years he was far from affluent. Knight of the Legion of Honour and of several foreign orders, he felt that his work had entitled him to election to the Institut de France, an honour which he greatly coveted, and for which he was often proposed.[2] There exists a pamphlet of great rarity, which he composed with a view to putting his qualifications before the electors of the Institut; it is entitled, "Notice Analytique sur les Travaux de Géologie, de Paléontologie et de Zoologie de M. Alcide d'Orbigny" (Paris,

[1] XXI., pp. 441, 451–3.

[2] He was presented for election to the Institut no less than eight times. 1st. Oct. 29, 1838, to fill the vacancy caused by the death of Baron Cuvier (Comptes Rendus, vii., p. 765). 2nd. Dec. 2, 1844, to fill the place of Geoffroy-St. Hilaire (C.R., xix., p. 1215). 3rd. May 13, 1850, to fill the place of de Blainville (C.R., xxx., p. 611). 4th. Feb. 3, 1851, again to fill the place of de Blainville (C.R. xxxii., p. 148). 5th. Dec. 29, 1851, to fill the place of Beudant (C.R., xxxiii., p. 715). 6th. April 12, 1852, to fill the place of Savigny (C.R., xxxiv., p. 568). 7th. March 9, 1857, to fill the place of Élie de Beaumont (C.R., xliv., p. 523). 8th. April 20, 1857, to fill the place of Constant-Prévost (C.R., xliv., p. 839). Mme. Henri d'Orbigny tells me that at the time of his death he was again a candidate, but had been obliged to abandon his candidature on account of his ill-health. He was "presented" five times by the Section of Zoology, and three times by that of Mineralogy.

1856).[1] He failed, however, as we have seen, to secure admission to this august body. Professor Marcellin Boule says rightly that it was a disgrace to the Institut that he was not elected, and his biographer, in the Encyclopædia of Larousse, observes that his important works clearly designated him for this honour. He was several times President of the Geological Society of France. In 1849, on the title-page of the "Cours Elémentaire," he described himself as "Professeur suppléant de Géologie à la Faculté des Sciences de Paris." He had for some years applied in various directions for a Professorship, but these efforts also proved abortive until 1853, when Napoleon III. founded a Chair of Palæontology at the Muséum d'Histoire Naturelle, and d'Orbigny was elected to it as first Professor. Fischer has admirably summed up the record of these last years. He says: "The Zoologists did not appreciate his original discoveries with regard to the geographical distribution of animals, any more than his efforts to establish the Classification of the Foraminifera, the Bryozoa, or the Cephalopoda; they attached no importance to such painstaking labours of specification and taxonomy; the Geologists were exasperated by the ideas of this innovator; his terminology of the zones evoked a chorus of recrimination and ridicule; in a word, Zoologists and Geologists agreed in a remarkable manner in declaring that Palæontology was not a Science, but merely the Zoology or Botany of fossil creatures." After his election to the Chair of Palæontology, "it might have been supposed that thenceforward the new Professor would enjoy peacefully the position which he regarded as the supreme object of his career. But this was not the case. Weary of the struggle, harassed by mean enmities or by ill-concealed jealousies, he sought in hard work an access of fatigue to obliterate the wounds which were not spared him, and which perhaps he felt too deeply. He shut himself up more assiduously in the midst of his beloved collections; but this kind of life ended by undermining his robust health, a disease of the heart supervened with all its train of suffering and anxiety. Ere long work became impossible for him, and after a year of suffering, death brought him deliverance on the 30th June, 1857, at the comparatively early age of fifty-five."[2] Professor Boule tells us, "in spite

[1] This is the title and date as given by Fischer (VII., p. 453). It is doubtless a revision and enlargement of a quarto pamphlet of 28 pp., entitled, "Notice Analytique sur les Travaux de M. Alcide d'Orbigny, Auteur du Voyage dans l'Amérique Méridionale." Paris, n.d. Imp. F. Loquin, 16 Rue Notre Dame des Victoires. It is a *catalogue raisonné* of his papers as given by Fischer down to the paper on American swallows (Comptes Rendus, Ac. Sci., vii. (1838), read December, 1837). This would appear to fix the date of this issue of the opusculum as 1838, which is that of his first candidature.

[2] XXI., p. 450. This account is repeated practically verbatim by Labonnefon, who adds, "He died as he had lived, a Christian" (XXII., p. 14). After the death of d'Orbigny the Chair remained vacant till 1861, when the Vicomte d'Archaic

of his merits d'Orbigny did not find favour with the 'Princes of Science.' . . . D'Orbigny was badly received in this Jardin des Plantes, of which he has become one of the glories. They gave him as a laboratory a few dilapidated rooms situated among the attics, and he had no collections."[1] He was buried at Pierrefitte, near St. Denis, on July 2, 1857, "amid a numerous concourse of notabilities." A funeral oration was pronounced on his tomb by M. Daman, President of the Société Géologique, of which a few copies were printed, and upon which Labonnefon has drawn freely in his Biography (Bibl. XXII.). It is at La Rochelle, as I have pointed out (*ante*, p. 5), that his memory has been the most honoured, and that his name continues to be the most revered.

All through his life, though he never published his "grand ouvrage," he never lost interest in the Foraminifera, and we are told that "nothing gave him greater pleasure than presents of dredgings, in which he was certain to discover new forms."[2]

Of the existing portraits of d'Orbigny I reproduce two: one (Plate I.) from the "Lithograph from Life," executed by Émile Lavallée in 1839 and published as a frontispiece in vol. i. of the "Voyage dans l'Amérique Méridionale"; the other (Plate VII.) skilfully restored from a faded Daguerreotype which hangs in the studio of Professor Marcellin Boule, who has kindly furnished me with a copy. It dates from the year 1843. There is a bad bust of him in terra-cotta in one of the niches on the garden front of the Museum of Palæontology in the Jardin des Plantes, and a medallion portrait in the cornice of one of the rooms of the K.K. Naturhistorische Hofmuseum in Vienna, on the Maria-Theresien Platz façade.[3] There is also a medallion portrait of him on the walls of the Museum of Natural History at La Plata (Argentine Republic).

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was appointed. He was succeeded for a few months in 1868 by Edouard Lartet, after whose death there was some question of suppressing the post, but finally d'Orbigny's brother-in-law, Albert Gaudry, was appointed in 1872 (June 8). Gaudry was succeeded on his retirement in 1903 by the present occupant of the Chair, Professor Marcellin Boule, to whom I am indebted for much assistance in the preparation of this Memoir. (See his "Leçon d'Ouverture," La Paléontologie au Muséum et l'Œuvre de M. Albert Gaudry (Revue Scientifique, May 28, 1904) for a succinct account of the life and work of his predecessor.)

[1] In a later passage he observes, "In 1853 the State gave d'Orbigny a Chair of Palæontology with the title of Professor-Administrator, but it gave him nothing to administer. They did not dare to confide to him the national collections of fossils which were divided between several professors. D'Orbigny had to rely upon his own private collections for his lectures" (Revue Scientifique, May 28, 1904).

[2] XXI., p. 436.

[3] See the Catalogue of the Vienna Museum, published in 1902.

XV.—The Verdict of Posterity.

Apart from the observations of some of his rivals upon controversial points in the teaching of d'Orbigny, and apart from Deshayes (see *ante*, p. 30), the first writer who set himself seriously to criticize d'Orbigny's classification and general method was the late W. B. Carpenter, in his "Introduction to the Study of the Foraminifera," published in 1862. It is hardly too much to say that whenever occasion serves, Carpenter's criticism takes on the nature of an attack, an attack the force of which is not infrequently neutralized by being founded upon an insufficient or superficial equipment for the purpose.

The first work of Carpenter on the Foraminifera was published in 1849,[1] and after this came a series of specialized Memoirs in the "Philosophical Transactions of the Royal Society," and it was these elaborate and laborious researches into the minute structure and affinities of the Foraminiferal shell which clearly demonstrated the hopeless futility from a zoological point of view of the arbitrary classification of d'Orbigny. Carpenter tells us himself, "When, some years since I undertook to prepare for the Ray Society an outline view of the structure, physiology, and systematic arrangement of the Foraminifera generally, I had no idea of contributing anything else than an Introduction to my friend Professor W. C. Williamson's 'Recent Foraminifera of Great Britain.'[2] With the progress of my own researches, however, I came more and more strongly to feel how unsatisfactory are the results of the method pursued by M. d'Orbigny and by those who have followed his lead, both as regards the multiplication of *species*, the distinction of *genera*, and the grouping of these genera into families and orders."[3] At the same time it must be borne in mind that the minute structure and consequential affinities of the Foraminifera had already engaged the attention of Williamson, and the conclusions of Carpenter were adumbrated by him in his first published papers on the genus Lagena and upon the microscopic structure of Polystomella.[4]

Carpenter, however, was the first to voice the conclusion, which must have been forcing itself before his day upon Rhizopodists—that "*sharply defined divisions*, whether between species, genera,

[1] W. B. Carpenter, "On the Microscopic Structure of Nummulina, Orbitolites, and Orbitoides," Q. J. Geol. Soc., vi. (1850), pp. 21–39, pls. iii.–viii.

[2] Published by the Ray Society in 1858.

[3] XVII., p. v.

[4] W. C. Williamson, "On the Recent British Species of the Genus Lagena," Ann. Mag. Nat. Hist., ser. 2, i. (1848) pp. 1–20, pls. i.–ii.; and "On the Structure of the Shell and Soft Animal of *Polystomella crispa*," etc., Trans. Micr. Soc. London, ii. (1849) pp. 159–178, pl. xxviii.

families, or orders, *do not exist among Foraminifera*," and he applied this principle with rigour. Indeed, we find in his opening pages an echo of d'Orbigny's life axiom (see *ante*, p. 12) when he says: "I have endeavoured throughout my own scientific career to keep in view the noble character given by Schiller of the true philosopher, as distinguished from the trader in science, that 'he has always loved truth better than his system, and will gladly exchange her old and defective form for a new and fairer one.'"[1] No student of the group can afford to ignore—indeed, I might say that every student must commit to memory—the eight "general propositions" with which Carpenter concludes the preface to his remarkable work, though since 1862 the great advance which has been made in the knowledge of the fossil forms tends to modify some of his broader generalizations. His primary answer to d'Orbigny is contained in his Fifth Proposition: "The evidence in regard to the genetic continuity between the Foraminifera of successive geological periods, and between those of the later of those periods and the existing inhabitants of our seas, is as complete as the nature of the case admits," and he adds immediately, "there is no evidence of any fundamental modification or advance in the Foraminiferous type from the Palæozoic period to the present time."[2]

The points of failure inseparable from the d'Orbignyan system are clearly and concisely set out by Carpenter in his Historical Summary (I have pointed them out in these pages, and they do not require recapitulation now), and he concludes that notwithstanding the immense value and extent of d'Orbigny's contributions to this branch of Zoology—and he sets out all that is admirable in d'Orbigny's work—there is scarcely any part of his work which will stand the test of time and further research.[3]

The researches of Carpenter into the intimate structure of the shells made it clear that the d'Orbignyan classification must be entirely disregarded; that the very same type may develop itself either as a Stichostègue along a straight or slightly curved axis, or as a Hélicostègue along a spiral axis; and that certain of the Cyclostègue order are generically if not specifically identical with certain Hélicostègues. He deals shortly with the work of Ehrenberg, the failings of which had been pointed out by d'Orbigny (*ante*, p. 56), and which, he properly remarks, is based upon views so erroneous that it is seldom or never referred to in the present day, save as a matter of historical interest; but at the same time we must not lose sight of the fact that it is to Ehrenberg that we owe practically the discovery of the great importance of the Forami-

[1] XVII., p. vii.
[2] XVII., p. xi. Compare Carpenter's earlier quoted dictum, *ante*, p. 63. See also our paper referred to, *ante*, p. 64.
[3] XVII., p. 6.

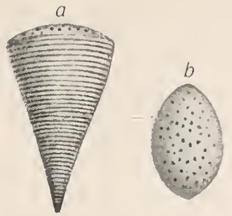
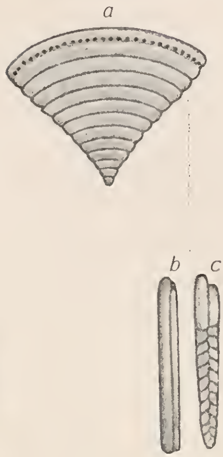


Fig. 1. *Conulina conica*, after d'Orbigny.



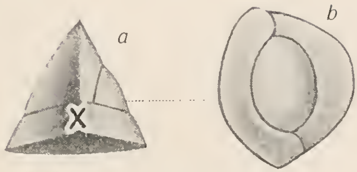
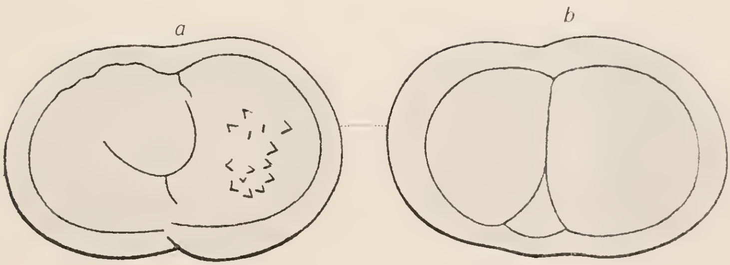


Fig. 4. *Cruciloculina triangularis*, after d'Orbigny and Carpenter.

Fig 2. *Cuneolina pavonia*, after d'Orbigny and Carpenter.



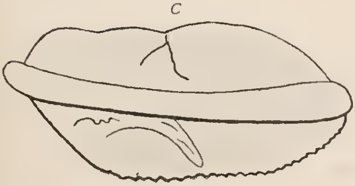


Fig. 5. *Rotalia dubia*, after Fornasini, from the Planches inédites.

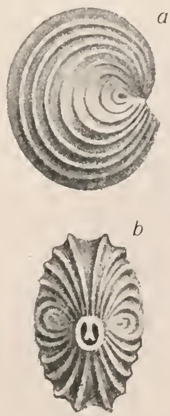


Fig. 3. *Uniloculina indica*, after d'Orbigny.

Plate X. Some d'Orbignyan Species.

nifera in Chalk,[1] though d'Orbigny, working independently at the same time, had produced his Paris Basin Memoir, and had noted many of the Cretaceous forms in the "Tableau Méthodique" in 1825.[2] Unfortunately, Ehrenberg's magnum opus, the "Mikrogeologie," is so vast and confused a work, so difficult of reference, and so discounted by his practice of figuring only species as viewed by transmitted light, as to be practically useless to the systematist[3] (vide *ante*, p. 56). It was Ehrenberg, also, who first called attention to the presence of glauconitic casts of Foraminifera in the Greensands that occur from the Silurian upwards.[4]

We need not stop to consider the classification proposed by Schultze in 1854, which left much to be corrected, and that of Bronn in 1859, which was a combination of the systems of d'Orbigny and Schultze. It was, however, Schultze who first —after Dujardin, whose observations he confirmed—made any systematic study of the living animal.[5] He recognized the truth of d'Orbigny's axiom that a few months of what may be called "field-work," properly directed, is worth more than an entire lifetime spent consulting compilations in the studio.[6]

I have referred to some of d'Orbigny's unaccountable sins of omission, his failure for many years to recognize the genus Lagena (*ante*, p. 52)[7] and Bolivina (*ante*, p. 53). That he should have entirely ignored the Foraminiferal nature of Nubecularia is remarkable, for it is one of the commonest of the Mediterranean forms, and must have been present in great quantity in his material, showing the highly distinctive Textularian, Rotalian, and Nodosarian arrangements of chambers which are a feature of this protean genus, though Carpenter says[8] that his *Webbina rugosa*[9] was referable to Nubecularia, a determination of the correctness of which I am far from being assured. It would be impossible to

[1] C. G. Ehrenberg, "Ueber die Bildung der Kreidefelsen und des Kreidemergels durch unsichtbar Organismen," Abhandl. k. Akad. Wiss., Berlin (1838), 1839, pp. 59-147, pls. i.–iv.

[2] See XXV., pp. 244, 326, 383. Ehrenberg would appear to have been the first to make microscopic examination of thin sections of Foraminifera, but he fell into the error of regarding them as Bryozoa.

[3] "Mikrogeologie: Das Wirken des unsichtbaren Kleinen Lebens auf der Erde," 2 vol., fol., Leipzig, 1854. Parker and Jones made an heroic effort to make this work available to the student of the Foraminifera in their "Nomenclature," Ann. Mag. Nat. Hist. ser. 4, ix. (1872), pp. 211–230, 280–303; x. (1872), pp. 184–200, 253–271; and appendix, pp. 453–457.

[4] His first paper on the subject was his "Ueber den Grünsand und seine Erläuterung des organischen Lebens," Abhandl. k. Ak. Wiss. Berlin (1855), pp. 85–176, pl. i.–vii. This was followed by several other papers in the same and following years. (See Sherborn's Bibliography.)

[5] M. S. Schultze, "Ueber den Organismus der Polythalamien (Foraminiferen)," etc., Leipzig, 1854.

[6] XV., p. xv.

[7] We must bear in mind in this connexion the imperfections of his earlier microscopes. Even in 1839 he regarded the smallest Foraminifera as measuring "no more than a half, a quarter, or even a sixth of a millimetre" (VII., p. viii).

[8] XVII., p. 69.

[9] VIII., pl. i., figs. 16–18; XII., pl. xxi., figs. 11–12.

point out within the scope of this work the numberless misplaced affinities arising from the d'Orbignyan system of classification. Carpenter never spares him, and, whilst rendering thus a great service to Rhizopodists, he is, in my opinion, too insistent in his scorn of d'Orbigny, the fundamental error having once been clearly established. The infinitesimal variations from type which he admitted as of sufficient importance to deserve specific rank have been referred to, but it is rather staggering, regard being had to his immense number of shadowy species of Miliolidæ, to find him saying that "We should find it difficult to find genera more distinct from one another than those of this order. They present forms so clearly differentiated that there are really no passage forms among them, and a few hours' study will always be sufficient to enable us to distinguish between them."[1] The forms, in point of fact, graduate into one another so insensibly that it is very difficult to draw any sharp lines of demarcation between them.[2] Only a working systematist can appreciate the wild luxuriousness of his imagination when dealing with the Rotaline forms, of which Brady has justly said, "most of his species are quite worthless, some of them not even representing varietal distinctions of sufficient permanence to notice."[3]

No doubt some of d'Orbigny's critics regarded him as a lunatic, doubtless he was a lover, and most certainly he was a poet, and one is tempted to quote Theseus in the "Midsummer's Night's Dream," and to think that sometimes "his eye in a fine frenzy rolling" gave to airy nothings "a local habitation and a name." It is curious also that d'Orbigny should not have expressed more correct views upon the genus Amphistegina (which does not seem to have arrested the attention of any previous observer), for, as I have pointed out (*ante*, p. 11), the material at his disposal was practically unlimited, most of the little bottles at La Rochelle containing pure gatherings of this genus, presenting all its variations of form. His description was, as Carpenter says, taken upon trust by all his followers, and its true nature was not revealed until Williamson discussed its minutest structure in 1851.[4] It is perhaps unfair to take d'Orbigny to task for his superficial errors in dealing with the Nummulites; as we have seen (*ante*, p. 19) he was afraid of them, and I cannot help remarking that this is an attitude which appears to have been adopted by many eminent Geologists and Rhizopodists since his day.

[1] XII., p. 256.

[2] See especially W. K. Parker's paper, "On the Miliolitidæ of the East Indian Seas," Trans. Micr. Soc., London, n.s., vi. (1858), pp. 53–59, pl. v.

[3] H. B. Brady, "On the Rhizopodal Fauna of the Shetlands," Trans. Linn. Soc. London (Zool.) xxiv. (1864), p. 469.

[4] W. C. Williamson, "On the Minute Structure of the Calcareous Shells of some recent Species of Foraminifera," Trans. Micr. Soc., London, iii. (1851), pp. 105–128, pls. xvii., xviii.

For the verdict of posterity, then, we come back to the opening paragraph of the present work. Many have been the eulogies pronounced upon him by writers of a later age by no means blind to his faults. Their views are summed up by von Zittel, who is unsparing of whatever praise is due to him, when he says, "The chief merit of d'Orbigny's works is their remarkable precision and lucidity of statement which opened their contents to Geologists of all nations, and enabled them to exert a great influence upon literature."[1] At the present day the general tendency among Geologists in France is to adhere firmly to d'Orbigny's sub-divisions and nomenclature, and where necessary to form sub-groups and sub-stages.[2] Even though the bases of his classification be panoplied with the dim magnificence of myth, even though his system of nomenclature has produced results which strike terror to the heart of the most sturdy systematist, so long as the Foraminifera engage the attention of Zoologists, of Geologists, of Biologists, one name must always stand at the head of those of their predecessors, one name must recur continually in their work, one name must always be held in an esteem which may be described as affectionate, and that is the name of Alcide d'Orbigny.

XVI.—Some d'Orbignyan Species.[3]

It is not necessary to refer further than has been done in the foregoing pages, and in Appendices E, F, to the genera which, originally instituted by d'Orbigny, have disappeared by absorption into other well-known genera; but there are a few which fill the Systematic Rhizopodist with a justifiable curiosity, species of highly typical appearance which he figured adequately in his Memoirs, but which, as such, have disappeared excepting as hereinafter noted. These are the genera Conulina, Cuneolina, Uniloculina, and Cruciloculina; and to them may be added a fifth—*Rotalia dubia*, a species which has recently made a sensational reappearance after suffering an eclipse of ninety years.

Into this category also might have entered *Peronina flabelliformis*, of which he not only gave a figure in the Atlas to the "Tableau Méthodique" (pl. x., figs. 10, 11), but also supplied a Model (No. 56). He recorded it from Madagascar in 1826, and described it as not having been found elsewhere in 1839,[4] and again in 1846, when he figured it once more. He described it as

[1] XXV., p. 507.

[2] Ibid., p. 525. See also Marcellin Boule, "The divisions which he established in the series of the Secondary Epoch have been but slightly modified; his nomenclature is still universally adopted" (Revue Scientifique, May 28, 1904).

[3] This section is written in collaboration with my friend Arthur Earland.

[4] I., p. 260, No. 1; VII., p. 25; XII., p. 72.

common, and as allied to Frondicularia (which it does not in the least resemble except slightly as to outline), and named it after the somewhat rare alga *Ulva* (*Padina*) *pavonia*. Carpenter did not touch it, but Parker and Jones, going by the figures and Model, suggested in 1863 that "possibly it is a symmetrical Peneroplis; more probably a semidiscoidal modification of Orbitolites,"[1] and in 1865, as "perhaps an Orbiculina."[2] Brady, however, found it again in sand from Madagascar in 1877 (or from the Seychelles; perhaps from both), and we have given a full account of its reappearance when we described and figured it as a fairly common species from the Kerimba Archipelago.[3]

Conulina appears first, as a Stichostègue, in the Cuba Memoir,[4] as having been found there; d'Orbigny promises a Model of it, No. 101 in the mysterious "Fifth Instalment,"[5] and gives a figure (pl. i., figs. 15, 16) of the only species of the genus *C. conica*, which is here reproduced in Plate X, fig. 1. In the Vienna Memoir he repeats the diagnosis and the figure, adding nothing. It is, as its name denotes, a perfectly regular, laterally compressed cone, about twice as broad as it is long, with a vast number of closely set sutural lines apparently denoting flat, discoid chambers. The aperture is cribrate, consisting of a quantity of coarse foramina on the surface of the ultimate chamber. It was stated by Reuss and Fritsch to be a "living" or recent form, when they attempted a Model of it in 1861, which, however, carries us no farther, as they constructed their Model presumably from d'Orbigny's description and figures.[6] D'Orbigny in 1850 described another and gigantic species, *C. irregularis*, 12 mm. in length, from the Chalk (Etage 21me, Turonien) of five districts in France, but this is a *nomen nudum*.[7] And there d'Orbigny leaves it. The description of the genu by d'Orbigny is unsatisfactory in so far that it gives no clue to the texture of the shell, but he remarks that it approaches Orthocerina in its general form, which would appear to be sufficient to preclude an arenaceous test. Reuss in his catalogue places it among the Arenacea, but on what grounds there is no evidence. Parker and Jones,[8] basing their surmise on the position assumed

[1] XVIII., p. 440.

[2] XIX., p. 27. They call it "Pavonia, possibly a misprint for Pavonina." It was: the misprint was their own, however.

[3] See XXVII., p. 633, and Proc. Zool. Soc., London (1915), p. 295, where the previous references are given in full and discussed. They are somewhat confusing.

[4] VII., p. 24.

[5] See Appendix D.

[6] The Reuss-Fritsch Models, intended to supplement and complete the Models of d'Orbigny, were issued in 1861 with a catalogue which is reproduced verbatim by Parker and Jones (XIX., pp. 37–41). There would appear to have been a second issue of them in 1865, referred to by Sherborn as the originals "Issued later." The numbering of these as given by Sherborn in his "Index of the Foraminifera" (*passim*) is entirely different to that in the 1861 catalogue, and appears to follow no order of classification at all akin to that of the principal issue and catalogue.

[7] XV., vol. ii., p. 210, No. 356.

[8] XIX., p. 38.

by Reuss, suggest *Lituola nautiloidea* Lam. The locality given by d'Orbigny, "living in the Island of Cuba and the Antilles," appears to us to furnish a much more probable explanation of its affinity. By far the most abundant Foraminifer in shallow water in the West Indies is *Orbiculina adunca* (F. & M.), which occurs in endless varieties from nautiloid to discoid, and, more rarely, in an elongate crozier form.[1] The crozier portion is occasionally of quite small proportion to the series of produced chambers, and if the spiral crozier portion were broken away or suppressed, as sometimes occurs in Peneroplis,[2] a structure resembling d'Orbigny's figure, with a cribrate terminal surface, would result. We have, therefore, no hesitation in referring the genus Conulina to this variety of *Orbiculina adunca.*

Cuneolina appears first, as an Enallostègue, in the Cuba Memoir, recorded as a fossil from the Chalk and Greensand of the mouths of the Charente. Of this he likewise announces a ghost-model, No. 110 in the "Fifth Instalment," but he gives no figure until he repeats the same diagnosis of the genus in the Vienna Memoir and figures the species *C. pavonia* (pl. xxi, figs. 50–52); we reproduce this figure in Plate X, fig. 2. He also cites without any description two other species, *C. conica* and *C. Fleuriausa* (or *Fleuriausiana*).[3] In the "Prodrome" he cites all three species from the Etage 20me (Cenomanien) of the Chalk, merely saying that *C. conica* is narrower than *C. pavonia,* and *C. Fleuriausa* is narrower still.[4] Carpenter recognizes this species and reproduces d'Orbigny's figure,[5] and his description of it is excellent. He says it is "nothing less than a Textularian, which is extremely compressed in a direction transverse to the normal direction of its compression; for if we could imagine a Textularian with globose chambers to be composed of a plastic substance, it can easily be conceived that whilst, by pressure applied to the two axial *faces,* those two faces might be extended and thinned out until they represented the flat triangular shape which distinguishes Cuneolina (each face being divided by the axial line on the two sides of which the two series of chambers would still be disposed), a like pressure being applied to the two margins would flatten the two series of chambers against one another so as to convert what were before the margins into lateral faces and to bring what were before the axial faces into the condition of margins" (see Plate X, fig. 2). The only discordant opinion as to the relation of Cuneolina with Textularia is that of Schlumberger,[6] expressed in a short note in which, in a

[1] See A. Earland, "On *Orbiculina adunca* (F. & M.) and its Varieties," Journ. Quekett Micr. Club, ser. 2, vi. (1898), pp. 88–92.
[2] *Cf. Monalysidium polita* Chapman. (See XXVII., p. 603.)
[3] VII., p. 150; XII., p. 253, pl. xxi., figs. 50–52.
[4] XV., vol. ii., p. 186. [5] XVII., p. 193, pl. xii., fig. 17.
[6] C. Schlumberger, "Note sur le Genre Cuneolina," Bull. Soc. Géol. France, ser. 3, xi. (1883), pp. 272–3.

single paragraph, he, on the ground of some observations which he appears to have made by means of sections, denies the relationship to Textularia and places the genus in the group of Orbitolina. He gives no figures, and does not appear to have written further on the subject. K. Martin[1] refutes Schlumberger's observations and confirms Carpenter's conjecture as to its relationship (*supra*). Goës[2] describes and figures an abnormal Textularian, as "very common," in the Caribbean Sea, which in its lateral compression strongly suggests d'Orbigny's Cuneolina. Goës refers it to *Textularia trochus* d'Orb., but at this date Goës was differentiating specific forms to a very limited extent only, and the form which he figures bears only a most distant relationship with d'Orbigny's Cretaceous species *T. trochus.* Finally, in going through Mr. Edward J. Halkyard's slides and material from the Blue Marl (Bartonien) of the Côte des Basques, Biarritz, and in preparing his MS. for publication, we have found a species, named by Halkyard *Textularia biarritzensis*, which is clearly referable to this genus. His description and figures, with our observations thereupon, will be published in due course in the Proceedings of the Manchester Literary and Philosophical Society.

Uniloculina makes its first appearance in the Cuba Memoir among the Agathistègues, as a recent form from the Indian coast, and in the Vienna Memoir he gives a figure, and announces in both places another mysterious Model, No. 111 of the "Fifth Instalment."[3] Reuss-Fritsch attempt a Model (No. 16: No. 82 in Sherborn). D'Orbigny's species *U. indica* is clearly a particularly reniform (or kidney-shaped) type of the early, or "adelosine" stage of a strongly sulcate Miliolina (cf. *M. pulchella*). It need not, therefore, detain us (see Plate X, fig. 3);[4] and the same course might be taken with Cruciloculina, which has exactly the same d'Orbignyan history as Uniloculina,[5] and is, in addition, figured for the first time in the South American Memoir (pl. ix, figs. 11, 12), in its only species, *C. triangularis.*[6] It was found only on the Patagonian coast, and is merely a variety of *Miliolina tricarinata*,

[1] K. Martin, "Untersuchungen ueber den Bau von Orbitolina (Patellina auct.) von Borneo." Paleontologie van Nederlandsch, Indie. Verh., No. 29, pp. 86–108, in Jahrb. Mijn. Ned. Ost Indie., xvii. (1889). See p. 102.

[2] A. Goës, "On the Reticularian Rhizopoda of the Caribbean Sea." K. Svenska Vet. Ak. Handl., xix., No. 4 (1882), p. 80, pl. v., figs. 167-170; pl. vi., figs. 171–2.

[3] VII., p. 161; XII., p. 261, pl. xxi., fig. 53-54.

[4] Parker refers to the genus and gives a figure (op. cit., p. 74, note 2, fig. 1), and it has been referred to in systematic works, but it has only been revived or accepted by Terquem in his paper on the Dunkerque Foraminifera (Paris (1875-6), pt. 3, p. 132, pl. xvii., figs. 8*a*, *b*), who gives the name *Uniloculina orbignyi* to a somewhat similar megalospheric primordial stage of a sulcate Miliolina, probably *M. bicornis.* We have found identical specimens of this stage of *Miliolina pulchella* in the shore sands at Chatelaillon.

[5] VII., p. 182; XII., p. 280, pl. xxi., fig. 57.

[6] IX., p. 72, pl. ix., figs. 11, 12.

whose aperture is practically closed, by four valves converging towards the centre with a cruciform space between them.[1] It is questionable whether it really is entitled to specific, to say nothing of generic rank, but it is the same class of shell as Schlumberger's *Triloculina fulgurata* and *T. fischeri*, which are characterized by remarkable dendritine apertures.[2] It may also be compared with Munier-Chalmas and Schlumberger's genus Idalina, or indeed any of the "Miliolidées trématophorées."[3] Carpenter devotes some attention to this genus and reproduces d'Orbigny's figure. However, this exact form of Miliolid does not appear to have been observed or recorded since d'Orbigny's celebrated voyage (see Plate X, fig. 4).

A more remarkable resurrection than even that of Pavonina was the identification by Earland and myself of the lost d'Orbignyan species *Rotalia dubia*, of which almost all that can be said at present with certainty is that it is not a Rotalia.

The form made its re-appearance, after a lapse of nearly a century, in the material brought from the Kerimba Archipelago by Dr. J. J. Simpson, which formed the subject of our recent monograph on the locality (Bibl. XXVII.), and there can be no doubt that d'Orbigny's specimens—or specimen, for we have only found one among his types in Paris—came from the same material as his *Pavonina flabelliformis*. We published a preliminary note on the species,[4] which we may usefully repeat and amplify.

When we first discovered the specimens we were unable to assign them to any definite position, although their rhizopodal nature was unquestionable. Subsequent research caused us to associate the forms with Fornasini's published figure, which we reproduce (Plate X, fig. 5),[5] representing d'Orbigny's original sketch of a form to which he gave this name in the "Tableau Méthodique."[6] Fornasini's opinion was that the rhizopodal nature of d'Orbigny's organism was more than doubtful, his opinion, however, being based entirely upon Berthelin's tracing of d'Orbigny's original sketch. It must be borne in mind that Fornasini's figure represents merely Berthelin's tracing from one of the direct sketches of d'Orbigny (see *ante*, p. 36, Division V), the surface markings or papillæ being merely partially indicated. We thereupon proceeded to verify Fornasini's figure, and to compare our specimens with the original type-specimen in Paris, and we had no hesitation in deciding that the two forms were

[1] See XVII., pp. 75, 80, pl. vi., fig. 15.
[2] C. Schlumberger, "Feuille des Jeunes Naturalistes," Ann. xiii. (1883), p. 107, pl. ii., figs. 1, 2.
[3] See Bull. Soc. Géol., France, ser. 3, xiii., pp. 273 *et seq.*
[4] XXVII, p. 546.
[5] C. Fornasini, "Illustrazione di Specie Orbignyane di Nodosaridi, etc., istituite nel 1826," Mem. Acc. Sci. Ist., Bologna, Ser. 6, v. (1908) p. 46, pl. i., fig. 14.
[6] I., p. 274, No. 34.

identical, although d'Orbigny's species is only represented by a single water-worn individual, whereas the Kerimba dredgings have furnished us with two or three distinct stages of growth, or possibly species, of the genus. Some are spherical and relatively smooth, others are oval and coarsely papillate. D'Orbigny's type-specimen is of the latter kind. We have now also identified specimens of the organism from Cebu, Philippine Islands (45 fms.), and the Java Sea (50 fms.), so that it would appear to be widely distributed. Quite recently Joseph Wright of Belfast has found specimens of the form in sands from Mauritius, both of the round and oval papillate types. The exact affinities of the form are, however, still very obscure, and, pending further investigation and the discovery of further specimens, we merely recorded it under d'Orbigny's original name in our Table of Species and Varieties in the Kerimba Monograph. It will almost certainly require the establishment of a new genus, if not of a new sub-family.

XVII.—The Foraminifera of the Biscayan Coast of France in the Neighbourhood of La Rochelle.

In the opening section I have spoken of Esnandes, and in a subsequent note (p. 12) I have given some details upon the town of Chatelaillon. In all d'Orbigny's works he refers so frequently to the palæontology of these two districts that it is clear that he took full advantage of his propinquity to the latter, and to his residence in the former, to make a very extensive and minute examination of the geological strata which occur at both. It is therefore not a little remarkable that whilst out of the wealth of recent Foraminifera of the shores he only gave the district as the habitat of two species of Polymorphina (see *ante*, p. 11), from the wealth of fossil forms which must indubitably occur in the beds at both places he recorded no forms at all.[1] We have not examined these beds for Foraminifera, but, as will presently be seen, many fossil forms derived from them occur, as might be expected, in the shore-sands of the adjacent coasts.

It seemed to me that an examination of the earliest recent material to which d'Orbigny had access could not fail to possess a highly specialized interest for the Rhizopodist, and I therefore made a sufficient gathering of material from the two places in the spring of 1914.

The most placidly functional lord of the most unimpressionable

[1] Madame Henri d'Orbigny tells me that in a volume of early sketches by Alcide d'Orbigny now in her possession there are six pages inscribed "Foraminifères fossiles de Grignon, Esnandes, Marsilly—Coquilles libres." It will be remembered that d'Orbigny assumed a biological distinction between free and attached species (see p. 23). I have not at present been able to inspect these drawings.

Plate XI. Esnandes : The Strand at high-water mark.

scientific bosom could hardly fail to respond to a strong emotional stimulus, as the mechanism which it controls stands at low tide upon the sandy margin of the mud-flats of the Anse de l'Aiguillon, radially scarred in all directions by the hurrying *acons* of the *boucholeurs,* for it is here that the boy Alcide must have wandered continually in search of zoological and geological specimens, and it is here that his scientific career received its first real impetus. The expanse of strand between high water-mark and the cliffs, which are known as "Les Rochers d'Esnandes," is not more than a few yards in some places, and never more than thirty, and it presents a busy spectacle at all hours of the day as the *boucholeurs* go out, come in, wash their mussels in pools which they dig on the shore for the purpose, and load them upon the carts which take them to market (Plate XI). At all times groups may be seen attending to the hurdles which are being got ready to replace superseded ones in the *bouchots,* and it must be confessed that if these people live wholly or for the most part upon Mollusca, as d'Orbigny tells us (*ante,* p. 5), or are descended from a race of rigid mytilophagists, they provide a powerful argument against those who view all edible Lamellibranchs with mingled scorn and suspicion.

At our feet are broad deposits of Foraminifera, lying either upon the edges of the mud-flats or upon the sandy patches left clean by the receding tide; at our back are cliffs rising from the earth by the eastward dip of the strata, so that as one walks to the Pointe St. Clément he may note every zone at a level convenient for examination. They are composed of a friable white Upper Jurassic chalk, from which Foraminifera can be washed with great ease. D'Orbigny himself speaks of the "calcaire jurassique du département de la Charente Inférieure," in which the preservation of the fossils in their natural condition seems astonishing.[1] The formation according to the latest French stratigraphists is the Séquanien; they are what, for all practical purposes, we may call in British terminology the Corallian zone at the top of the Middle Oolite. In the "Cours Elémentaire" d'Orbigny places it in his "XIII^me^ Etage, Oxfordien";[2] for him the "XIV^me^ Etage, Corallien,"[3] makes its appearance at Marsilly, a few kilometres eastward. At Chatelaillon, which, as we have seen, is farther south from La Rochelle, we are upon a higher zone of the formation, distinguished by the modern French stratigraphists as "Pterocerien et Séquanien." The little town lies upon an immense alluvial plain, the outcrops and substratum being Upper Jurassic Marls, ranging in colour from yellow to deep blue, of which d'Orbigny has given us a carefully worked out geological

[1] I., p. 246. [2] XIV., vol. ii., pp. 523, 526–7.
[3] XIV., vol. ii., pp. 538, 541–2. (See *ante,* p. 65.)

section, which he places in his "XV[me] Etage, Kimmeridgien." [1] The fossil forms therefore, which are white at Esnandes and yellow or blue at Chatelaillon, may for our purposes be all described, as I have said *supra*, as Corallian (Upper Jurassic). The shore at Chatelaillon is (see note 1, p. 12) a broad expanse of sharp sand, ideal for a bathing resort,[2] strewn here and there with patches of Molluscan débris from which I made the gatherings which are analysed in this paper. The only rivers which find their way to the coast near either locality arrive by way of the alluvial plains from rocky watersheds of volcanic origin, so that we may eliminate the possibility of any of the fossil forms being derived from strata other than those which we have indicated.

A glance over the tabular list hereto appended will remind us of many observations which I have had occasion to make in the foregoing pages, and will emphasize the statement that d'Orbigny was prone to generalize on such insufficient material that his observations upon the geographical distribution of Foraminifera are entirely fallacious and misleading. The occurrence of no less than twenty-four species of the genus Lagena representing all the most strikingly differentiated general types, makes us marvel at his unconsciousness of the existence of the genus until 1839; and the fact that he never recorded any species of Bolivina until he named the genus from Bolivia, also in 1839, is shown to be no less remarkable. But what is more extraordinary still is that he made no home-record, so to speak, of *Nonionina depressula*, which, as might be expected upon such a shore, constitutes (as I have been at the pains to ascertain) 99 9 p.c. of the Foraminifera of the Esnandes shore-sand and mud-flats. His warmer interest was clearly concentrated upon the exotic material which reached him from all over the world; he may be said to have carried the axiom "omne ignotum pro magnifico" to its ultimate expression. The virtual non-appearance of any arenaceous, adherent forms was to be expected at Esnandes, but one would have expected them to be present in the detached condition at Chatelaillon, washed in from the oyster-beds which flourish there as on all parts of this south Biscayan coast. The wealth of algæ in the neighbourhood would lead one to look for *Nubecularia lucifuga*, of which we have only found a single specimen. These idiosyncrasies of facies are however to be met with in deposits and shore-sands from all over the world.

Plate XII represents a group of the typical Foraminifera of the shore-sand and mud-flats of Esnandes; Plate XIII, a similar group from the shore-sand of Chätelaillon.

[1] XIV., vol. ii., pp. 554–7.

[2] It may be useful to remark, in case any of my readers should propose to visit this coast, that if he asks for a "Billet de Bains de Mer" at the Montparnasse Station in Paris, he will get a return ticket for about half the normal rate, which is comparatively expensive.

TABULAR LIST OF SPECIES.

In the following list VVC or VC = very common; C = common; F = frequent; R = rare; VR = very rare; 1 = one specimen only. All are recent unless particularized, but (f) = fossil; (f & r) = fossil *and* recent.

	Species	Esnandes	Chatelaillon
	NUBECULARIINÆ.		
1	*Nubecularia lucifuga* Defrance	—	1
	MILIOLININÆ.		
2	*Biloculina depressa* d'Orb.	VR	—
3	*Spiroloculina nitida* d'Orb.	R	R
4	*S. grata* Terq.	R	—
5	*S. excavata* d'Orb.	R	VR
6	*S. planulata* (Lam.)	—	VR
7	*S. planissima* (Lam.)	—	1
8	*Miliolina circularis* (Born.)	VC	VC
9	*M. labiosa* (d'Orb.)	VR	—
10	*M. subrotunda* (Montagu)	—	VR
11	*M. suborbicularis* (d'Orb.)	VR	—
12	*M. trigonula* (Lam.)	VR	C
13	*M. tricarinata* (d'Orb.)	1	VR
14	*M. cultrata* Brady	—	VR
15	*M. durrandii* Millett	F	VR
16	*M. bosciana* (d'Orb.)	F	—
17	*M. oblonga* (Mont.)	C	R
18	*M. seminulum* (Linné)	C	C
19	*M. araucana* (d'Orb.)	1	—
20	*M. planciana* (d'Orb.)	—	VR
21	*M. candeiana* (d'Orb.)	C	—
22	*M. auberiana* (d'Orb.)	C	C
23	*M. cuvieriana* (d'Orb.)	—	R
24	*M. agglutinans* (d'Orb.)	—	VR
25	*M. fusca* Brady	VR	—
26	*M. contorta* (d'Orb.)	C	F
27	*M. sclerotica* (Karr.)	—	R
28	*M. ferussacii* (d'Orb.)	VR	VR
29	*M. lævigata* (d'Orb).	VC	C
30	*M. bicornis* (W. & J.)	—	F
31	*M. pulchella* (d'Orb.)	—	VR
32	*M. longirostra* (d'Orb.)	—	VR
33	*M. brongniartii* (d'Orb.)	—	R
34	*M. boueana* (d'Orb.)	C	—
35	*Massilina secans* (d'Orb.)	VR	R
36	*M. secans* var. *tenuistriata* Earland	VR	F
37	*Sigmoilina ovata* Sidebottom	R	F
	PENEROPLIDINÆ.		
38	*Cornuspira selseyensis* H-A. & E.	F	—
39	*C. involvens* Reuss	F	—

TABULAR LIST OF SPECIES—*continued.*

	Species	Esnandes	Chatelaillon
	ASTRORHIZIDÆ.		
40	*Iridia diaphana* H-A. & E.	VR	—
41	*Psammosphæra fusca* Schulze	—	C
42	*Haliphysema tumanowiczii* Bow	VR	—
	LITUOLIDÆ.		
43	*Haplophragmium pseudospirale* (Will.)	—	1
44	*H. canariense* (d'Orb.)	F	—
45	*H. globigeriniforme* (P. & J.)	VR	—
46	*H. humboldti* Reuss	—	F (f)
47	*H. humboldti* var. *latum* Andreæ	—	F (f)
48	*H. acutidorsatum* Hantken	—	VR (f)
49	*H. placenta* Reuss	—	VR (f)
50	*Placopsilina cenomana* (d'Orb.)	—	1 (f)
51	*Ammodiscus incertus* (d'Orb.)	—	VR (f)
52	*Trochammina squamata* J. & P.	VR	—
53	*T. ochracea* (Will.)	1	—
54	*T. plicata* (Terq.)	VR	—
55	*T. inflata* (Montagu)	VC	—
56	*T. inflata* var. *macrescens* Br.	C	—
	TEXTULARIIDÆ.		
57	*Textularia gramen* d'Orb.	—	1
58	*T. conica* d'Orb.	F	VR
59	*T. minuta* Berthelin	—	VR (f)
60	*Verneuilina polystropha* Reuss	F	C
61	*V. tricarinata* d'Orb.	—	VR (f)
62	*Spiroplecta biformis* P. & J.	—	1 (f)
63	*Gaudryina pupoides* d'Orb.	—	1
64	*G. filiformis* Berthelin	VR	—
65	*Clavulina obscura* Chaster	VR	—
66	*Bulimina pupoides* d'Orb.	F	C
67	*B. elegans* d'Orb.	C	C
68	*B. elongata* d'Orb.	VR	—
69	*B. fusiformis* Will.	R	—
70	*B. elegantissima* d'Orb.	F	VR
71	*B. marginata* d'Orb.	C	VR
72	*B. echinata* d'Orb.	—	VR
73	*B. squammigera* d'Orb.	VR	—
74	*Virgulina schreibersiana* Czjzek	R	—
75	*Bolivina punctata* d'Orb.	C	VR
76	*B. nobilis* Hantken	F	VR
77	*B. textilarioides* Reuss	VR	F
78	*B. lævigata* (Will.)	VR	—
79	*B. dilatata* Reuss	C	VR
80	*B. difformis* (Will.)	R	—
81	*B. tortuosa* Brady	1	—
82	*B. ænariensis* (Costa)	VR	—
83	*B. variabilis* (Will.)	C	VR
84	*B. plicata* d'Orb.	C	—
85	*Cassidulina lævigata* d'Orb.	VR	1
86	*C. crassa* d'Orb.	VR	R
87	*C. nitidula* (Chaster)	VR	—

TABULAR LIST OF SPECIES—*continued.*

	Species	Esnandes	Chatelaillon
	LAGENIDÆ.		
88	*Lagena globosa* (Mont.)	VR	VR (r & f)
89	*L. lineata* (Will.)	F	—
90	*L. costata* (Will.)	—	1
91	*L. hexagona* (Will.)	VR	—
92	*L. reticulata* (Macgillivray)	VR	—
93	*L. squamosa* (Mont.)	VR	VR
94	*L. lævis* (Mont.)	F	VR
95	*L. semistriata* Will.	C	C
96	*L. perlucida* (Will.)	F	VR
97	*L. curvilineata* Balk. & Wr.	1	—
98	*L. striata* (d'Orb.)	VR	—
99	*L. sulcata* (W. & J.)	VC	VR
100	*L. williamsoni* (Alcock)	C	C
101	*L. clavata* (d'Orb.)	VC	C
102	*L. gracillima* (Seg.)	VR	—
103	*L. lævigata* (Reuss)	F	—
104	*L. semilineata* Wright	1	—
105	*L. acuta* (Reuss)	1	—
106	*L. lucida* (Will.)	C	C
107	*L. annectens* Burr & Holl.	VR	—
108	*L. quadrata* (Will.)	VR	—
109	*L. marginata* (W. & B.)	VR	—
110	*L. marginata* var. *inæquilateralis* Wright	1	—
111	*L. orbignyana* (Seg.)	F	F
112	*Nodosaria communis* d'Orb.	VR	—
113	*N. proxima* Silvestri	1	—
114	*N. scalaris* (Batsch.)	VR	—
115	*Cristellaria crepidula* (F. & M.)	1	—
116	*C. rotulata* (Lam.)	VR	VR (f)
117	*C. planiuscula* Reuss	—	VR (f)
118	*Polymorphina lactea* (W. & J.)	VR	VR (r & f)
119	*P. gibba* d'Orb.	1	VR
120	*P. oblonga* Will.	VR	—
121	*P. compressa* d'Orb.	VR	—
122	*P. communis* d'Orb.	1	—
123	*P. sororia* Reuss	VR	—
124	*P. angusta* Egger.	—	VR (f)
125	*P. guttula* d'Orb.	VR	—
126	*P. concava* (Will.)	1	—
127	*P. myristiformis* Will.	—	F
128	*Uvigerina canariensis* (d'Orb.)	—	1 (f)
129	*U. tenuistriata* Reuss	VR	—
130	*U. angulosa* Will.	F	VR
131	*Ramulina aculeata* (d'Orb.)	VR	—
	GLOBIGERINIDÆ.		
132	*Globigerina bulloides* d'Orb.	C	F
133	*G. dubia* Egger.	—	VR
134	*G. rubra* d'Orb.	F	—
135	*G. conglobata* Brady	—	R
136	*G. marginata* Reuss	—	1 (f)
137	*Orbulina universa* d'Orb.	—	VR

TABULAR LIST OF SPECIES—*continued.*

	Species	Esnandes	Chatelaillon
	ROTALIIDÆ.		
138	*Spirillina vivipara* Ehrenb.	VR (f & r)	F (f & r)
139	*S. margaritifera* Will.	—	VR
140	*Patellina corrugata* Will.	VR	VR
141	*Discorbina nitida* (Will.)	VR	VR
142	*D. millettii* Wright	—	VR
143	*D. prægeri* H-A. & E.	R	F
144	*D. peruviana* (d'Orb.)	VR	VR
145	*D. rosacea* (d'Orb.)	VR	C
146	*D. planorbis* (d'Orb.)	—	C
147	*D. baccata* H-A. & E.	—	VC
148	*D. turbo* (d'Orb.)	—	VR
149	*D. orbicularis* (Terq.)	VR	VR
150	*D. mamilla* (Will.)	—	1
151	*D. globularis* (d'Orb.)	C	C
152	*D. valvulata* (d'Orb.)	VR	—
153	*D. vesicularis* (Lam.)	—	—
154	*D. parisiensis* (d'Orb.)	VR	—
155	*D. wrightii* Brady	1	—
156	*Planorbulina mediterranensis* d'Orb.	C	C
157	*Truncatulina refulgens* (Montf.)	—	C
158	*T. lobatula* (W. & J.)	VR	C
159	*T. variabilis* d'Orb.	—	VR
160	*T. ungeriana* (d'Orb.)	—	VR
161	*Pulvinulina repanda* (F. & M.)	—	1
162	*Rotalia beccarii* (Linné)	C	VVC
163	*R. orbicularis* (d'Orb.)	VR	VR
164	*R. perlucida* H-A. & E.	VR	R
	NUMMULINIDÆ.		
165	*Nonionina depressula* (W. & J.)	VVC	VVC
166	*N. granosa* d'Orb.	C	—
167	*N. asterizans* (F. & M.)	C	VR
168	*N. pauperata* Balk. & Wr.	VR	—
169	*N. boueana* d'Orb.	1	VR
170	*N. turgida* (Will.)	R	—
171	*Polystomella decipiens* Costa	VR	—
172	*P. striatopunctata* (F. & M.)	VC	VC
173	*P. striatopunctata* var. *selseyensis* H-A. & E.	VVC	VVC
174	*P. crispa* (Linné)	—	F
175	*P. faba* (F. & M.)	F	F
176	*P. faba* var.	R	—
177	*P. macella* (F. & M.)	F	C
178	*P. listeri* d'Orb.	—	VR

NOTE.—For the purpose of this list we have revived some of d'Orbigny's obsolete specific names, so as to identify some of his figured types.

APPENDIX A.

The Family of d'Orbigny.

The family of d'Orbigny, of which records exist in French archives dating from 1444, when Barons of that name served Louis XI. of France, became extinct on the death of Henri d'Orbigny on June 29, 1915.

The grandfather of Alcide d'Orbigny was one of three brothers, established as colonists and planters in San Domingo, François d'Orbigny Dessalines, d'Orbigny de Bourg-blanc, and d'Orbigny de Coerts. it being the habit of French colonists (as indeed it has ever been of the landed gentry of France) to add to their own the names of their estates. François d'Orbigny was the owner of a large force of negro slaves, one of whom, by name Jacques, became, after the Revolution of the slaves in San Domingo, first Governor-General, and then the "Emperor" Jacques I. of Haiti. This creature instigated the massacre of the entire d'Orbigny family with the exception of two sons who were at the time completing their education in France. François d'Orbigny, his wife (*née* Madeleine de Beaudemont), and their sixteen other children having perished, and the plantation being razed by fire, the slave Jacques assumed the name "Dessalines," which gave rise to a legend which I found extant in La Rochelle in 1914, to the effect that d'Orbigny was in some way a direct descendant of this insurgent black.[1]

[1] This is the account furnished me by Mme. Henri d'Orbigny from the archives of the d'Orbigny family. It must be confessed that the published biographies of the "Emperor" Jacques Dessalines vary greatly from the above. The writer of his life in Larousse says he was the slave of a black potter (*potier*) called Dessalines, whose name he adopted, that this negro Dessalines was alive in 1805 in San Domingo (at Cap Francais, now Cap Haiti), and had recorded that Jacques was "an obstinate dog but a good workman." We are told that Jacques always remained fond of his old master, and on his accession to power made him his chief wine-steward, because he was a good judge of wine and a drunkard. The history of Jacques I. of Haiti is bloody but picturesque, and is inseparably bound up with the successive revolutions of the slaves in San Domingo, beginning with that of Ogé, of whom a lurid account is given by Lamartine in his "Histoire des Girondins" (Paris, 1847, ii., pp. 88, *et seq.*). According to Larousse, Jacques became Governor-General (as "Dessalines") in 1804, when he ordered a massacre of the white French population which lasted six months. He became Emperor as Jacques I. in 1805 (June 16). According to d'Orbigny in the "Voyage dans les deux Amériques, augmenté de renseignements exacts jusqu'en 1853, Nouvelle édition publiée sous la direction de M. Alcide d'Orbigny," (Paris, 1853), this date should be October 8, 1804. The first edition of this book, "Voyage pittoresque dans les deux Amériques," was published in 1841—I have not been able to see this edition in England—and consists of a condensation of his "Amérique Méridionale," augmented by notes of later travellers. Another edition forms part of Dumont d'Urville's "Histoire Générale des Voyages," 4 vol., Paris (1859), iii.

Of the two sons who by their absence in France escaped massacre, Charles Marie, born at sea as already related (see p. 3), and registered at Port Malo (San Domingo), January 2, 1770, was the father of Alcide d'Orbigny, whose career forms the subject of this Memoir. The other, Melchior d'Orbigny, returned to San Domingo to endeavour to save what was left of the family property, and is said to have perished at sea on the journey thither.

Charles Marie married (as stated) Marie Anne Pipat on October 20, 1799, and had seven children. 1. Estelle born in 1880, died in 1893 (see p. 4). 2. Alcide, the subject of this Memoir. 3. Melquior, who died at the age of eleven years. 4. Charles, born at Coueron December 12, 1806, whose career has been set forth (see p. 8). 5. Edouard (see note 2, p. 9). He made a study of marine algæ, but published nothing. His two youngest sons, Louis and Marcel, aged respectively seventeen and thirteen years, were already passionate geologists and were killed by a land-slide at the Falaise de la Pointe du Chai near La Rochelle whilst hunting for fossils. 6. Salvador, born December 17, 1808, died in 1883. 7. Théophile, who died in 1820, aged seven years.

Alcide d'Orbigny married first Paméla Martignon, who died August 2, 1842, by whom he had one daughter, Noémi, who died unmarried at the age of twenty-four. His second wife was Marie Gaudry, daughter of the Usher (Bâtonnier) of the Order of Advocates to the Court of Appeal in Paris, and sister of Albert Gaudry, the Geologist, Membre de l'Institut, and Honorary Fellow of the Royal Society of London, who later held d'Orbigny's Chair of Palæontology in Paris (see p. 70, note).[1] By his second wife, who was born August 29, 1824, and died in Paris, October 23, 1903, he had three children. 1. Henri Joseph d'Orbigny, born May 16, 1845, died June 29, 1915 (see p. 87).[2] Until the age of fifty he followed, reluctantly, the profession of an architect, after which he devoted his life to Entomology, on which he published many important works. He married Marie Thérèse Bedel, daughter of a Conseiller à la Cour d'Appel, who still lives in Paris (1916), and to whom I am indebted for most of this information regarding the family. 2. Berthe, born June 20, 1847, married Jules Déville, and died January 23, 1908. 3. Isabelle, born September 26, 1849, married

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The book is identical, the plates worn. In this, also, it is stated that "Dessalines" was the slave of another negro, a "propriétaire" of San Domingo. After a short reign of appalling brutality "Jacques I." was murdered at Port au Prince, October 17, 1806. On the other hand, in a ghastly little book by Dubroca, "La Vie de J. J. Dessalines, Chef des Noirs Révoltés de Saint Domingue," Paris, Ann. xiii. (1804), we are told again that Jacques was the slave of a negro proprietor named Dessalines, but that his first action in the revolt was to murder his proprietor and assume his name. And there we must leave it. *Non nostrum tantas componere lites!* Mme. d'Orbigny assures me that the above account is entirely false, having been copied by one author from another, and that she has often heard the real story from the lips of Mlle. Estelle d'Orbigny (see p. 4, note 2), who had the account of his early life at San Domingo direct from her father.

[1] The father of Albert and Marie Gaudry was himself an enthusiastic collector of minerals. (See Marcellin Boule, op. cit., p. 70, *ante.*)

[2] He has sometimes been referred to as Marie Joseph d'Orbigny, that name appearing on a copy of his baptismal certificate, but the original gives his correct name Henri Joseph.

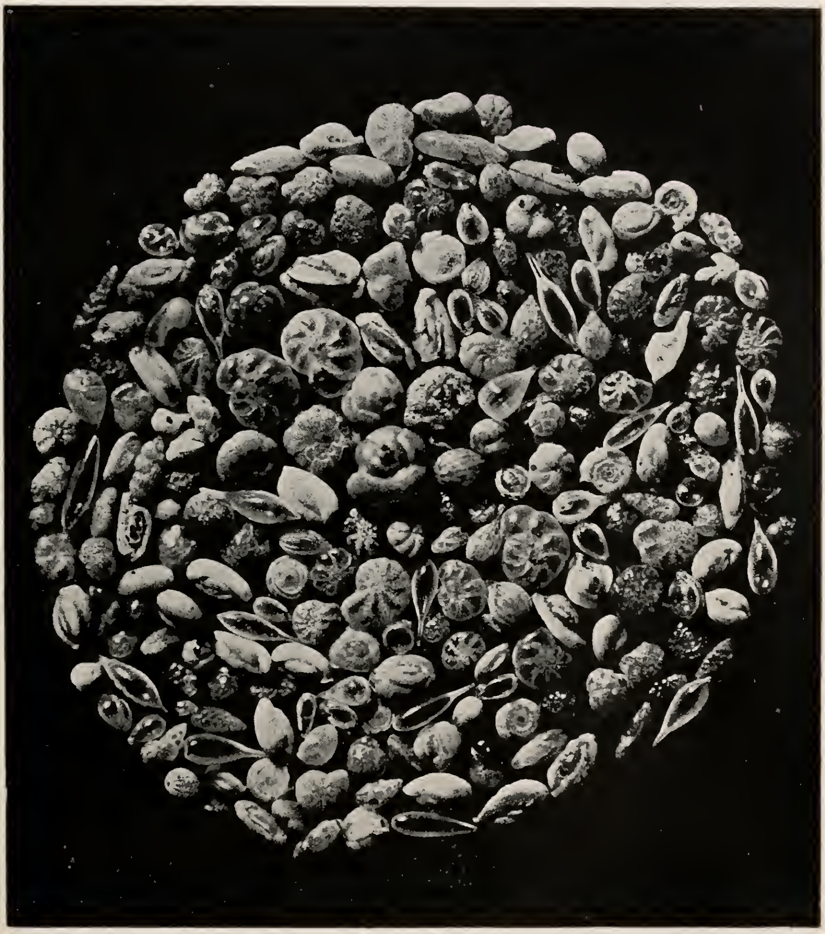


Plate XII. Group of Foraminifera from Esnandes.

Dr. Le Coin, and died December 8, 1914. The sons-in-law of Alcide d'Orbigny did not follow scientific pursuits.

Madame Henri d'Orbigny possesses her father-in-law's Microscope and a large mass of original drawings of Foraminifera, *et alia*, made by him. This is not the early Microscope referred to on p. 10, but a later instrument probably built especially for d'Orbigny to his own design. The date and maker are unknown (see Plate VI, fig. 2).

APPENDIX B.

Letter written by Charles d'Orbigny to his Son Alcide, aged Eleven Years, now in the Possession of Madame Henri d'Orbigny.

A la Blanche, 24 Mars, 1813.

Mon cher Alcide,

Je vois avec plaisir que *tout en t'occupant d'histoire naturelle* tu t'occupes aussi de l'histoire mangeante et buvante. Je verrai ton lézard avec plaisir et je compte aussi manger des choux-fleurs et pommes que tu dis si beau, et boire du vin de la vigne que tu dis si belle. Je t'embrasserai j'espère dans une douzaine de jours au plus tard et saurai de ta Maman si tu as été bien sage ; à présent que tu portes un habit comme un homme tu dois en prendre l'air posé, et commencer à réfléchir que sans l'étude on ne parvient à rien, qu'elle seule nous procure un état qui nous fait subsister, qu'elle nous procure tous les agréments de la vie, et la faculté inapréciable de juger tout ce qui nous entoure à sa juste valeur, de reconnaître un Sot sous un habit superbe, et de tendre la main avec bien du plaisir à l'homme instruit et honnête défiguré par la livrée de l'indigence. Sois toujours bon avec tout le monde, laisse la une bonne partie de ton étourderie qui était passable lorsque tu n'étais qu'un enfant mais qui commence à ne plus être de saison. Aime toujours bien toute la famille et je t'aimerai toujours autant que je t'aime.

C. d'Orbigny.

APPENDIX C.

The Dates of Issue of the Models.

In order to satisfy the requirements of rigid observers of the International Rules of Nomenclature it is necessary to establish the precise dates at which the four instalments of the Models were issued. This has been arrived at by a search through the volumes of de Férussac's "Bulletin des Sciences Naturelles et de l'Industrie" and the "Deuxième Section," entitled "Bull. des Sci. Nat. et de Géologie."

First Instalment.—This was announced in 1823 (Bull., vol. i., p. 60). The notice is compiled from the label on the box (see p. 14), the Paris dêpot being filled in "au bureau du Bulletin, Rue de l'Abbaye No. 13, ou l'on peut voir la première livraison déjà publiée, ainsi qu'au Muséum du Jardin du Roi." De Férussac appends an eulogistic note, and adds, "We know that MM. d'Orbigny, father and son, have applied themselves with unheard of zeal and patience to the observation of these 'Infiniment Petits.' The enterprise which we announce does much honour to M. d'Orbigny, jun., who executes it alone under the direction of his father. Naturalists will doubtless applaud it, and it deserves to be encouraged in order that it may continue to be extended even beyond the instalments promised."

Second Instalment.—This was announced in 1824 (Bull. Sci. Nat. et Géol., vol. i., p. 384). De Férussac in his note regrets that he cannot give further particulars, as these will only be issued with the fourth instalment. He says here, "the three or four actual specimens" are enclosed between two slips of glass. The "glass boxes" (see p. 14) had evidently been abandoned.

Third and Fourth Instalments.—In 1826 (Bull., vol. viii., p. 130) the final "prospectus" of the Models is abstracted, announcing the issue of the third and fourth instalments, with a copy of the "Prodrome général," which had been published in the Ann. Sci. Nat., accompanied by an Atlas of eight plates—reprints of pls. x.–xvii. of the Atlas to vol. vii. of the Ann. Sci. Nat. The six years' work of d'Orbigny on "cette innombrable quantité de petites espèces que l'on désignait vaguement sous le nom de Nautiles Microscopiques" are reviewed, and the principles of his classification are laid down. De Férussac's report upon these two instalments was published later (Bull., vol. ix., p. 247), when they had been issued for some months, and is merely a general eulogy of the whole work.

The pamphlet differs from that already cited in pagination, and in some particulars of the title-page which reads (in the advertisement) :—"Tableau Méthodique de la Classe des Céphalopodes par M. Dessalines d'Orbigny, Naturaliste-voyageur du Muséum d'Histoire Naturelle, précédé d'une Introduction par M. de Férussac : présenté à L'Académie Royale des Sciences dans la séance du 7 Novembre 1825. In 8vo de 150 pp. avec un Tableau et un Atlas de 8 planches in 4to lithographiées. Paris, 1826. M. Guerin, Rue des Fosses Saint-Victor, No. 14. Se vend avec la 4me. livraison des Modèles des Céphalopodes Microscopiques." Another pamphlet (a copy of which is in the Geological Library at South Kensington) has a title-wrapper, "Tableau Méthodique de la Classe des Céphalopodes," inside which a fuller title reads :—"Tableau Méthodique de la Classe des Céphalopodes; par M. A. Dessalines d'Orbigny, Membre de la Société d'Histoire Naturelle de Paris ; et Naturaliste-Voyageur du Muséum d'Histoire Naturelle, précédé d'une Introduction par M. de Férussac. (Présenté à l'Académie des Sciences dans la séance du 7 Novembre 1825.) (Extrait des Annales des Sciences d'Histoire (*sic*) Naturelle. Janvier. 1826.)"

There is no publisher or printer mentioned. There are a few lines of print at the foot of the page, and the next page (iii) is paged 7.

The pagination goes on up to 150, but it is quite different to that of the original in the Ann. Sci. Nat.

It would seem, therefore, that there were at least three different issues of the reprint from the Ann. Sci. Nat., which accounts for discrepancies in references and synonymies. Cf. de Férussac's "Additions et Corrections," published in 1827 (see p. 29).

The final "Prospectus" issued to advertise the Models in 1826 is of great rarity, few copies apparently having been preserved; there is one in the Geological Library at South Kensington. It is an elaborate pamphlet of eight pages, setting out the importance of the study of the "Céphalopodes Microscopiques," and their supposed relationship to the larger genera, with a short summary of the earlier authors who had dealt with them as "*Nautiles*." It points out the advantages of the method of presenting them to observers in the form of enlargements, and gives a long extract from Latreille's "Rapport." The "dépôt" as before is "chez M. Guerin," and at the offices of de Férussac's Bulletin in the Rue de l'Abbaye, No. 3.

APPENDIX D.

The "Cinquième livraison" of the Models.

In his Memoirs on the Cuba Foraminifera and on the Cretaceous Foraminifera of the Paris Basin we find this note in identical terms, referring to the original Models[1]: "This collection, which we propose to augment by an instalment devoted to the genera discovered since its first publication, and to the shells characteristic of the formations, is, as before, to be had at No. 5 Rue Louis le Grand, Paris." The Models to be included in the new instalment were as follows:—

101. Conulina. See VII., p. 24; XII., p. 71.
102. Webbina. See VII., p. 26; VIII., p. 125; XII., p. 73.
103. Flabellina. See VII., p. 42; X., p. 23.
104. Verneuilina. See VII., p. 104; X., p. 38; XII., p. 182.
105. Candeina. See VII., p. 108; XII., p. 192.
106. Faujasina. See VII., p. 109; XII., p. 194.
107. Chrysalidina. See VII., p. 109; XII., p. 194.
108. Gaudryina. See VII., p. 112; X., p. 43; XII., p. 197.
109. Sagrina. See VII., p. 149; X., p. 47; XII., p. 252.
110. Cuneolina. See VII., p. 150; XII., p. 253.
111. Uniloculina. See VII., p. 161; XII., p. 261.
112. Cruciloculina. See VII., p. 182; XII., p. 280.
113. Citharina. See VII., p. xxxvii.
114. Hauerina. See VII., p. xxxviii; XII., p. 118.
115.
116. Bolivina. See IX., p. 61; XII., p. 239.

[1] X., p. 2, note 2; VII., p. xxi, note 2.

Professor Marcellin Boule informs me that he can throw no light upon the Models above referred to; neither the moulds nor any of the Models are preserved with the others in his Laboratory at the Musée de Paléontologie, and he doubts whether they were ever issued. Mr. C. Davies Sherborn, who has made an exhaustive study of the Models, shares the same doubt, and his MS. list in the copy of the Catalogue issued with the Models, in the Library at the British Museum (Natural History), compiled as the result of his researches, lacks, like mine, the No. 115. I can find no indication anywhere of what this Model was intended to be. Madame Henri d'Orbigny, who possesses a very complete collection of d'Orbignyan works and unpublished documents, tells me that if any publication of these Models was ever made her husband did not possess it or know anything about it.

APPENDIX E.

The Generic and Specific Names of the d'Orbignyan Foraminifera.

The principles which guided d'Orbigny in his apposition of generic and specific names has been set out in this Memoir (see p. 17). We may say that "*liberavit animam suam*" upon the subject on pp. xlvi *et seq.* of the Introduction to the "Prodrome" (Bibl. XV.) in a lengthy and ingenious dissertation on the principles to be adopted. The most serious point to which exception must be taken was his view that the author of a species was to be regarded as he who removed the specific name into a new genus, a direct contravention of the accepted system. His view (*op. cit.* p. liii) was that it is inconvenient and unjust to both authors to make the original author responsible for a genus of which he was ignorant, and to deprive the author who removes a specific name to a new genus of the honour of his discovery and correction. Consequently in the "Prodrome" we find hundreds of names claimed by d'Orbigny, and so set down, which in conformity with accepted rules should have been ascribed to the first founder of the species: thus among the Foraminifera alone, *Polystomella crispa* is attributed to Lamarck, instead of (Linné);[1] *Orbitoides papyracea* becomes "d'Orbigny" instead of (Boubée),[2] and countless other instances might be cited. (See pp. 54 (note 2), 65, 66.)

Another principle which has more to commend itself is his objection to descriptive qualitative names such as *grandis*, *gigas*, *minutus*, and so on. "These names," he observes, "are only true when larger or smaller species are non-existent in the same genus," and he concludes that "among specific names those which have no reference to the form are the best, precisely because they mean nothing."[3]

[1] XII., p. 125. [2] XV., vol. ii., p. 334.
[3] XV., vol. i., Introd., p. 50.

A glance at any of his monographs shows that in almost every genus he gave the same *local* name—e.g., *canariensis*, *antillarum*, *patagonica*, *parisiensis*, and the like—to species in two or more genera, and he pursued the same confusing habit with some of his *personal* names; thus in the Canary Islands Monograph there are two species named after Webb, and no less than six after Berthelot, of course in different genera. In the Vienna Monograph we find eight species named after von Hauer. When we meet this among his "Agathistègues," and find the same specific name given to a Triloculina and a Quinqueloculina (e.g. *lævigata* and *planciana*), the path of the systematist becomes very thorny indeed.

This Appendix, however, is an excursion into Biography. His personal names divide into two classes, those which he explains in a biographical note, and those which are left unexplained, many of which latter are those no doubt of the "modestes savants" above alluded to, and are not to be found even in the list of his correspondents which closes the Introduction to the "Prodrome" (XV., vol. i., p. lvii), which acknowledges contributions from 151 persons as regards French, and 69 persons as regards foreign fossils.

I have not noted a vast number of names the species identified with which are either unknown to-day, or are submerged in other species, but the following is a list of some of them which are better known. No attempt has been made to identify or give references for many specific names, as Brownii, Jonesii, Catesbyi, Edwardsiana, Akneriana, Voltziana, Ungeriana, Dutemplii, Mayeriana, etc.; nor his Christian specific names, such as Adolphina, Josephina, Mariæ, Rodolphina, Antonina, and so on. I have merely noted down such information as I have come across whilst studying his works, and have not sought for further details such as may be found in Biographical Dictionaries.

Alvarez, Don Manuel. ". . . que nous avons eu le plaisir de connaître en Patagonie" (IX., p. 36). (*Polystomella alvareziana*; *Rotalina alvarezii.*)

Archiac, E. J. A. d' (1802–1869). Authority upon the Nummulites. (See Sherborn's Bibliography.) (*Frondicularia archiaciana.*)

Auber, M. ". . . de Cuba auquel nous devons beaucoup de Mollusques de cet Ile" (VII., p. 95). (*Quinqueloculina auberiana*; *Rosalina auberiana.*)

Baudouin de Solène. ". . . a bien voulu nous envoyer de Sens beaucoup de fossiles" (X., p. 24). (*Flabellina baudouiniana*; *Textularia baudouiniana.*)

Berthelot, Sabin. Author of "Hist. Nat. des Iles Canaries" (Bibl. VIII). (*Quinqueloculina berthelotiana*, etc.) (See p. 46.)

Beccarius (1672–1766). One of the earliest observers of Foraminifera. (*Rotalia beccarii.*)

Bosc, C. Author of a paper on Alveolina (VII., p. 68). (See p. 17 and Sherborn's Bibliography.) (*Quinqueloculina bosciana*; *Rotalina bosciana*, etc.)

Brongniart, A. (1770–1847). Famous geologist (I., p. 250). (*Quinqueloculina*; *Triloculina brongniartii*, etc.)

Buch, L. von (1774–1852). Traveller and geologist (XV., p. xxiv). (*Quinqueloculina buchiana*; *Bulimina buchiana.*)

Candé, F. de. "... zélé naturaliste dont nous avons cultivé l'amitié dans nos voyages" (VII., p. xi). (*Quinqueloculina candeiana*, etc.; Genus *Candeina*.)

Cuvier, L. C. F. D. G., Baron (1769–1832). Famous naturalist; author of "Le Règne Animal." (*Quinqueloculina cuvieriana*.) (See p. 48.)

Defrance, J. L. M. (1758–1850). Author of Articles on Foraminifera in Dict. Sci. Nat. (I., p. 250). (See p. 23.) (*Calcarina defrancii*.)

Faujas de St. Fond, B. (1741–1819). Famous geologist (VII., pp. xvii, 109). (Genus *Faujasina*.)

Férussac, J. A. Baron de (1786–1836). Zoologist. (See p. 12, *et passim*.) (See Sherborn's Bibliography.) (*Quinqueloculina ferussacii*, *Amphistegina ferussacii*, etc.)

Fichtel, L. von. Joint Author of "Testacea Microscopica," 1798. (See p. 56.) (*Triloculina fichteliana*; *Polystomella fichteliana*.)

Fleuriau de Bellevue, of La Rochelle. Geologist; d'Orbigny's first patron. (See p. 6.) (*Amphistegina fleuriansi*; *Cuneolina fleuriansa*.)

Gaimard, Paul. Naturalist on the Freycinet Expedition, 1818–20. (*Calcarina gaimardii*; *Operculina gaimardii*, etc.) (I., p. 250.)

Gaudichaud, Beaupré C. Botanist and pharmacologist; colleague of Gaimard as above. (*Calcarina gaudichaudii*; *Turbinulina gaudichaudii*, etc.)

Gaudry, A. Geologist; d'Orbigny's brother-in-law and successor at the Musée de Paléontologie. (Genus *Gaudryina*, *Cristellaria gaudryana*.)

Gerville, de. Geologist of Valognes (I., p. 250). (*Valvulina gervillii*; *Rotalia gervillii*.)

Grateloup, J. P. S. de (1782–18—). Geologist of the Gironde (I., p. 250). (See Sherborn's Bibliography.) (*Rotalia grateloupi*; *Nonionina grateloupi*, etc.)

Guérin, M. d'Orbigny's agent for the sale of the Modèles in Paris (I., p. 250). (*Rotalia guerini*.) (See p. 14, note 2.)

Haidinger. Editor of the "Naturwiss. Abhandlungen," etc. (*Quinqueloculina haidingerii*; *Rotalina haidingerii*.)

Hauer, J. Baron von. Austrian geologist and privy councillor (VII., p. xxxix; XII., pp. 84, 118 *et passim*). (See p. 57.) (Genus *Hauerina*; *Quinqueloculina hauerina*; *Rotalia hauerii*, etc.)

Isabelle, Arsène. Assisted d'Orbigny in South America (IX., p. 74). (*Rosalina isabelleana*; *Biloculina isabelleana*, etc.)

Lamarck, J. B. de M. de (1744–1829). Famous naturalist. (*Quinqueloculina lamarckiana*; *Nonionina lamarckii*.)

Lesson, R. P. Ornithologist and naturalist on the Duperrey Expedition, 1828 (I., p. 250). (*Amphistegina lessonii*; *Polystomella lessonii*.)

Linné, C. von (1707–1778). The father of Systematic Natural History. (*Triloculina linneiana*; *Rosalina linneiana*, etc.)

Lister, M. (1638–1711). Early naturalist. (*Polystomella listeri*.)

Lorne, Alfred. "... qui a bien voulu nous transmettre de la craie de ... Sens" (X., p. 15). (*Dentalina lorneiana*.)

Ménard de la Groix. One of d'Orbigny's early correspondents (I., p. 249). (*Rotalina menardii*.)

Michelin, H. Author of the "Iconographie zoophytologique," 1840–47 (XV., p. xlviii). (*Rotalina micheliniana*.)

PARTSCH, S. Austrian geologist and friend of von Hauer (XII., p. xi, note). (*Rotalina partschiana*; *Quinqueloculina partschii.*)

PLANCUS, J. (1693–1775). Early naturalist. (*Guttulina plancii*; *Robulina planciana*; *Triloculina planciana*, etc.)

POEY, M. ". . . naturaliste zélé de l'Ile de Cuba" (VII., p. 192). (*Quinqueloculina poeyi*; *Rosalina poeyi.*)

QUOY, J. R. C. Naturalist on the Freycinet Expedition (I., p. 250). (See p. 12.) (*Amphistegina quoyii.*)

ROBERT, M. Siberian traveller who sent material to d'Orbigny (XII., p. 203). (Genus *Robertina* (= *Bulimina*).)

SAGRA, RAMON DE LA. Author of "Histoire . . . de l'Ile de Cuba," 1839. (See p. 44.) (Genus *Sagraina*; *Quinqueloculina sagra*; *Rotalina sagra.*)

SAULCY, L. F. J. C. DE. Numismatist and archæologist; collected Mollusca, etc., on his "Voyage autour de la Mer Morte." (*Rosalina saulcyi.*)

SCHREIBERS, K. Austrian conchologist. (*Rotalina schreibersii*; *Triloculina schreibersiana.*)

SCHROTER, J. S. (1735–1808). German conchologist. (*Rotalia schrœteri.*)

SOLDANI, A. (1733–1808). Author of the "Testaceographia." (See p. 27.) (*Quinqueloculina soldanii*; *Rosalina soldanii*, etc.; Genus *Soldania* (obs.).)

THOUIN, O. L. One of d'Orbigny's early correspondents (I., p. 250). (*Polymorphina thouini*; *Operculina thouini.*)

VERNEUIL, E. P. DE. Geologist; collaborator with Murchison in Russia (XV., p. xxxvi). (Genus *Verneuilina*; *Dentalina verneuili*; *Frondicularia verneuiliana.*)

VILARDEBO, M. "Directeur du Musée d'Histoire Naturelle de Montevideo." (*Oolina vilardeboana*; *Rosalina vilardeboana.*) (IX., p. 19.)

WEBB, P. BARKER. Joint Author of "Hist. Nat. des Iles Canaries," 1839. (See p. 46.) (Genus *Webbina*; *Triloculina webbiana*; *Marginulina webbiana.*)

APPENDIX F.

A COMPARISON OF THE FOUR TABLES OF GENERA PUBLISHED BY D'ORBIGNY, 1826–48.

IT has been observed that, in spite of the wealth of material at his command prior to 1826, d'Orbigny did not recognize any monothalmous Foraminifera before his return from South America and the publication of the 1839–40 Memoirs. The family "Monostègues" does not therefore appear in the original Table. In his later Memoirs he transposed the families "Entomostègues" and "Agathistègues," and shifted his "Enallostègues" to a position between them.

(For the notes to this Appendix see end of Appendix F.)

Comparison of d'Orbigny's Four Tables of Genera, Published 1826–48.

Family	Genus (3)	1 Tableau Méthodique	2 Cuba, 1839	3 Vienna, 1846	4 Dict. Univ. d'Hist. Nat. 1844–5
Monostègues	Gromia	–	×	×	×
	Orbulina (4)	–	×	×	×
	Oolina (6)	–	(1)	×	×
	Amphorina	–	–	–	× (2)
Stichostègues	Nodosaria	×	×	×	×
	Lingulina	×	×	×	×
	Frondicularia	×	×	×	×
	Rimulina	×	×	×	×
	Vaginulina	×	×	×	×
	Marginulina	×	×	×	×
	Planulaire (7)	×	–	–	–
	Pavonina	×	×	×	×
	Conulina	–	×	×	×
	Webbina	–	×	×	×
	Dentalina	–	×	×	×
	Orthocerina (8)	–	×	×	×
	Glandulina (40)	–	×	×	×
	Citharina	–	× (30)	(5)	–
Enallostègues	Bigenerina (12)	×	×	×	×
	Textularia	×	×	×	×
	Vulvulina (9)	×	×	×	×
	Dimorphina	×	×	×	×
	Polymorphina (41)	×	×	×	×
	Virgulina	×	×	×	×
	(Sphæroidina) (10)	×	–	–	–
	Guttulina (11)	–	×	×	×
	Gemmulina (12)	–	×	×	×
	Globulina (11)	–	×	×	–
	Sagrina	–	×	×	×
	Cuneolina	–	–	×	×
	Bolivina (1)	–	–	×	×
Hélicostègues (13) (i) *Turbinoïdes*	Clavulina	×	×	×	×
	Uvigerina	×	×	×	×
	Bulimina	×	×	×	×
	Valvulina	×	×	×	×
	Rosalina (14)	×	×	×	×
	Rotalina (15)	×	×	×	×
	Calcarina	×	×	×	– (39)
	Globigerina	×	×	×	×
	Gyroidina (15)	×	–	–	–
	Truncatulina	×	×	×	×
	Planorbulina	–	×	×	×
	Anomalina	–	×	×	×
	Verneuilina	–	×	×	×
	Pyrulina (16)	–	×	×	×
	Candeïna	–	×	×	×
	Pupina (17)	–	×	–	–
	Gaudryina	–	×	×	×
	Faujasina	–	×	×	×
	Chrysalidina	–	×	×	×

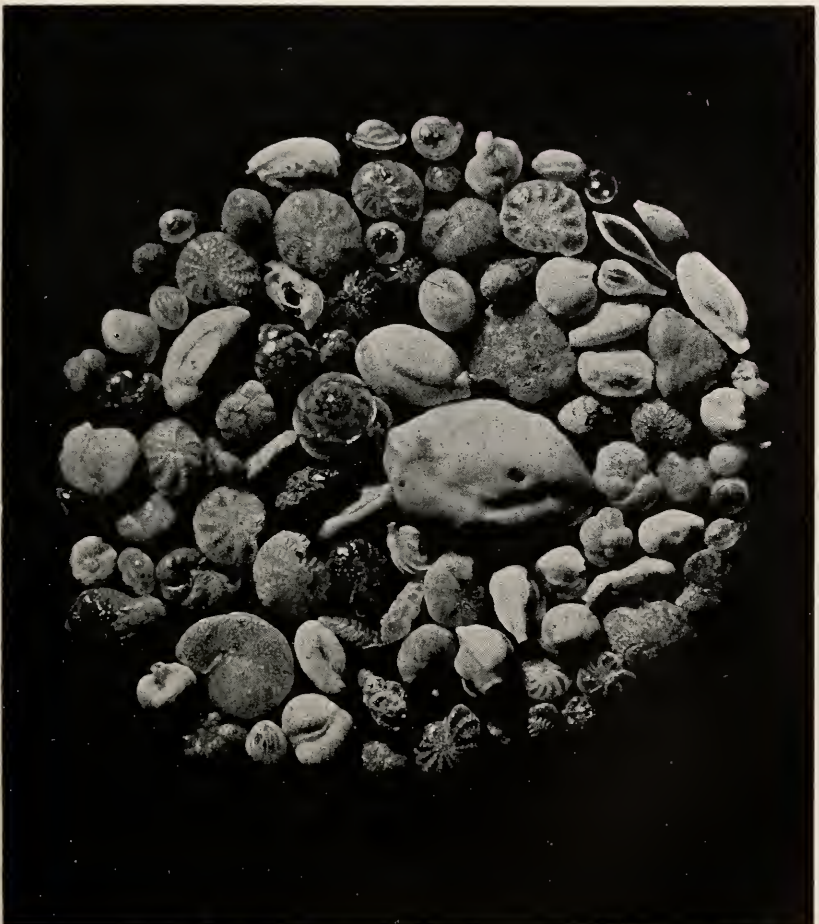


Plate XIII. Group of Foraminifera from Chatelaillon.

COMPARISON OF D'ORBIGNY'S FOUR TABLES OF GENERA, ETC.—*continued.*

Family	Genus (3)	1 Tableau Méthodique	2 Cuba, 1839	3 Vienna, 1846	4 Dict. Univ. d'Hist. Nat. 1844-5
(ii) *Ammonoïdes*	Planulina (18)	×	–	–	–
	(Planorbulina) (19)	×	–	–	–
	(Operculina) (20)	×	–	–	–
	Soldania (21)	×	–	–	–
(iii) *Nautiloïdes*	(Cassidulina) (22)	×	–	–	–
	(Anomalina) (23)	×	–	–	–
	Vertebralina	×	×	×	×
	Polystomella	×	×	×	×
	Dendritina (24)	×	×	×	×
	Peneroplis	×	×	×	×
	Spiroliua (24)	×	–	×	×
	Robulina (25)	×	×	×	×
	Cristellaria (43)	×	×	×	×
	Nonionina	×	×	×	×
	Nummulina (26)	×	×	×	×
	Siderolina (27)	×	×	×	×
	Flabellina	–	×	×	×
	Operculina (20)	–	×	×	×
	Orbiculiua	–	×	×	×
	Assilina (28)	–	×	×	×
	Alveolina	–	×	×	×
	Haueriua (29)	–	×	×	×
	Fusulina	–	–	×	×
	Cyclolina (31)	–	–	×	×
	Lituola (32)	–	–	×	×
AGATHISTÈGUES	Biloculina	×	×	×	×
	Spiroloculina	×	×	×	×
	Triloculina	×	×	×	×
	Articulina	×	×	×	×
	Quinqueloculiua	×	×	×	×
	Adelosina (33)	×	×	×	×
	Uniloculina (33)	–	×	×	×
	Fabularia	–	×	×	×
	Cruciloculina (34)	–	×	×	×
	Sphæroidina (10)	–	×	×	×
ENTOMOSTÈGUES	Amphistegina	×	×	×	×
	Heterostegina	×	×	×	×
	(Orbiculina) (35)	×	–	–	–
	(Alveolina) (35)	×	–	–	–
	(Fabularia) (36)	×	–	–	–
	Cassiduliua	–	×	×	×
	Asterigerina (37)	–	×	×	×
	Robertiua (38)	–	–	×	×

In 1852 he instituted a new family in the "Cours Elémentaire de Paléontologie," which he called Cyclostègues, to which he removed Cyclolina (from the Hélicostègues), and to which he added the genera Orbitolites, Orbitolina, and Orbitoïdes. (See note 31.)

It will be observed that some of the sub-genera in the *text* of the "Tableau" do not appear in the Table, but became genera in his later Tables. Some of these, e.g. Mucronina, Discorbina, Trochulina, Turbinulina, and Saracenaria, never appeared again as genera. In the headings to his genera in the Cuba and Vienna Memoirs Mucronina is absorbed into Nodosaria, Turbinulina into Rosalina, and Saracenaria into Cristellaria. Discorbina (*Discorbis* Lam.) was revived by Carpenter, Parker and Jones in 1862 (XVII., p. 199). Trochulina disappeared altogether.

Notes to Appendix F.

(1) The genera Oolina and Bolivina do not appear in the Cuba Memoir, but made their first appearance in the South America Memoir, published in the same year and immediately after it. All the other South American genera and all the Canary Island genera appear in the Cuba Memoir, in which he establishes genera for many species known to him from other localities but not found in the Cuba material.

(2) It will be observed that with the exception of Amphorina, a genus introduced here for the reception of Lagenidæ furnished with a more or less pronounced neck, the 1846 and 1844-5 Tables are identical. He never figured any Amphorina as such, but it is to be presumed that he would have transferred to the genus such species as Oolina (L) *clavata*, *striata*, and *striaticollis*. The genus was only adopted extensively by Segnenza ("Foraminiferi Monotalamici mioceniche di 1862), and twice (*A. elongata* and *A. gracilis*) by Costa.

(3) No attempt has been made to preserve any d'Orbignyan sequence of genera after 1826, as their order varies more or less in each Table.

(4) d'Orbigny did not adopt the Latinized termination *ina* until 1839. In 1826 the termination is invariably French:—Nodosaire, Linguline, Frondiculaire, Rimuline, etc.

(5) Included as a synonym of Vaginulina in 1846. The genus was only used (for single species) subsequently by von Römer, Schwager, and Reuss.

(6) = Lagena.

(7) = Cristellaria. (8) = Rhabdogonium.

(9) = Bigenerina (pars), Bolivina (pars).

(10) Removed (erroneously) in 1839 to "Agathistègues."

(11) = Polymorphina.

(12) In the text of the "Tableau" Gemmulina appears as a subgenus of Bigenerina.

(13) After 1826 d'Orbigny placed the "Nautiloïdes" before the "Turbinoïdes," and suppressed his second division, the "Ammonoïdes."

(14) = Globigerina (pars), Cymbalopora (pars), Discorbina (pars), Rotalia (pars), etc.

(15) = Pulvinulina (pars), Rotalia (pars).

(16) = Polymorphina. See note (41) below.

(17) Occurs in the Table on p. 30 of the Cuba Memoir, but not in the text or in any other Memoirs. It is apparently the same as Chrysalidina. See the note on this genus in Sherborn's Index.

(18) = Anomalina.

(19) Removed in 1839 to the class "Turbinoïdes."

(20) Removed in 1839 to the class "Nautiloïdes."

(21) = Cornuspira (pars), Cristellaria (pars), Planorbulina (pars). This genus disappeared after 1826, being apparently a kind of refuge-genus instituted by d'Orbigny for several species from Soldani's "Testaceographia," which he found himself unable to place (see p. 27). They have been discussed with some care by Parker and Jones. See XX., pp. 178–9, 238.

(22) Removed in 1839 to "Entomostègues."

(23) Removed in 1839 to the class "Turbinoïdes."

(24) = Peneroplis. (25) = Cristellaria.

(26) D'Orbigny observes in a note in 1826 (I., p. 295) that "Living species

having been discovered, we are compelled to change the termination—*ites* of the genus Nummulites." (27) = Calcarina.

(28) = Nummulites. In the text of the "Tableau" Assilina appears as a sub-genus of Nummulina.

(29) Described in a footnote to page xxxviii (Introduction) of the Cuba Memoir, but not in the work itself. It had been sent to him from Vienna by J. von Hauer by that date.

(30) Described in a footnote on p. xxxvii (Introduction) of the Cuba Memoir, but not in the work itself (see note 5).

(31) = Orbitolites (pars), and perhaps = Patellina (pars). See XVII., pp. 229–230, 233. This he removed in 1852 (XIV., vol. ii., p. 192) to a new family called Cyclostègues, which he placed between Monostègues and Stichostègues, to contain it, and Orbitolites, Orbitolina and Orbitoïdes. (See pp. 26, 66.)

(32) = Peneroplis.

(33) Generally regarded as an early or juvenile stage of several Miliolinæ. It is, however, still separated as a genus by some Rhizopodists. Uniloculina occupies the same category. We agree with Schlumberger that Adelosina is the megalospheric form of Quinqueloculina, "a megalosphere completely enveloped by the first chamber which becomes lenticular" (Bull. Soc. Zool. France, vol. xi., 1886, p. 557.).

(34) = *Miliolina tricarinata* with a cruciform aperture (see p. 78).

(35) Removed in 1839 to "Hélicostègues" (Nautiloïdes).

(36) Removed in 1839 to "Agathistègues."

(37) = Discorbina (pars), Rotalia (pars). (38) = Bulimina.

(39) The absence of the genus Calcarina in the table, both in this edition and in the later ones, is not explained.

(40) In the text of the "Tableau," Dentalina, Glandulina, Orthocerina, and Mucronina, appear as sub-genera of Nodosaria.

(41) In the text of the "Tableau," Guttulina, Globulina, and Pyrulina appear as sub-genera of Polymorphina.

(42) In the text of the "Tableau," Discorbina, Trochulina, and Turbinulina appear as sub-genera of Rotalia.

(43) In the text of the "Tableau," Saracenaria appears as a sub-genus of Cristellaria. It is referred to *Cristellaria italica*. See XVIII., p. 432; XIX., p. 32; XX., p. 246.

APPENDIX G.

Species named in the "Tableau Méthodique" not Diagnosed, Figured, or Identified by Parker and Jones, or by Fornasini.

1. Page 255, No. 43. *Dentalina depressa.*[1] [2]
2. „ 265, No. 13. *Polymorphina equalis.*[1] [2]
3. „ 279, No. 2. *Truncatulina elongata.*[2] Described as a fossil from Grignon and Parnes in XV., vol. ii., p. 407, No. 1327. "Grande espèce bombée." The species was recorded as a fossil by Terquem (Plage de Dunkerque, pt. 3, 1881, p. 126, pl. xvi., figs. 6 *a*, *b*; and Eocene of Paris, Mem. Soc. Géol. France, ser. 3, vol. ii., 1882, mem. 3, p. 93, pl. ix. (xvii.) figs. 26 *a b*).

[1] The "Tableau Méthodique" is the only reference given in Sherborn's Index.
[2] No synonomy in the "Tableau"; a d'Orbignyan species.

4. Page 294, No. 9. *Nonionina semistriata.*[1, 2] This is given as a synonym of *Polystomella burdigalensis* in XV., vol. iii., p. 155, No. 2885.
5. „ 307, No. 7. *Alveolina quoyii.*[2] It is difficult to surmise why this species was ignored by Parker and Jones, seeing that it was figured by d'Orbigny in the original plates in the Ann. Sci. Nat. (pl. xvii., figs. 11–13). It was figured again by Carpenter (XVII., p. 99, pl. viii., figs. 13–15, text figs. xxii., xxiii.) and by other authors subsequently. (See Sherborn's Index.) Parker and Jones merely refer to it by name in their paper on Alveolina (Ann. Mag. Nat. Hist., ser. 3, vol. viii., p. 168).

APPENDIX H.

Species added to the "Tableau Méthodique" in de Férussac's Additions and Corrections.

Espèces restées inconnues à M. d'Orbigny :—

Nautilus rugosus Linné, Syst. Nat., xii., Gramen et Siphunculus (*Nodosaria siphunculus* Lam).
„ *repandus* Fichtel and Moll., Éponide de Montf. (*Placentula pulvinata* Lam. and Blainv.).
„ *radiatus.*
„ *venosus.*
„ *sinuatus.*
„ *papillosus.*
„ *tuberosus* (*Cristellaria tuberosa* Lam.) Celle-ci est peut être la *Truncatulina tuberculata* de M. d'Orbigny.
„ *carinatulus* Dillwyn, Descript., Catal.
Rotalites lenticulina Lamarck, Ann. du Muséum.
„ *depressa* Lamarck „ „
„ *discorbula* Lamarck „ „
Lenticulites variolaria Lamarck „ „
Nummulites scabra Lamarck „ „
Lituolites difformis Lamarck „ „
Miliolites opposita Lamarck „ „
Orthocera acicula Lamarck, Anim. sans Vertebr.
„ *regularis* Blainville, Malacologie.

[1] The "Tableau Méthodique" is the only reference given in Sherborn's Index.
[2] No synonomy in the "Tableau"; a d'Orbignyan species.

Ajoutez les espèces suivantes :—

Page 252, No. 3	*bis.*	*Nodosaria subarcuatula* Montagu.
,, 253, No. 23	,,	,, *obliqua*, Linné.
,, ,, No. 27	,,	,, *jugosa* Montagu.
,, 254, No. 34	,,	,, *inæqualis* Linné (Gmelin).
,, 255, No. 42	,,	,, *bicarinata* Montagu.
,, ,, No. 48	,,	,, (*espèce incertaine*) Schroeter.
,, 265, No. 13	,,	*Polymorphina lactea* Montagu.
,, 276, No. 4	,,	*Calcarina stellata* d'Orbigny (from Spengler).
,, 287, No. 7		*Spirolina tenuis* Linné.

(The above pagination is taken from the original "Tableau" and not from de Férussac's "Additions.")

APPENDIX I.

ARTICLES BY PROFESSOR CARLO FORNASINI IN WHICH G. BERTHELIN'S TRACINGS OF THE D'ORBIGNY SKETCHES WERE REPRODUCED.

Mem. Ac. Sci. Ist. Bologna :—

1.	Ser. 5, vol. vii.	1898, p. 205.	*S. Pietro in Lama.*
2.	,, ,,	,, p. 239.	*Rotaline fossili.*
3.	,, ,,	1899, p. 639.	Polistomellini.
4.	,, vol. viii.	1900, p. 357.	*Foraminiferi Adriatici.*
5.	,, vol. ix.	1901, p. 45.	*Nodosarie Neogenici.*
6.	,, ,,	,, p. 371.	*Bulimine Adriatiche.*
7.	,, vol. x.	1902, p. 1.	Rimini.
8.	Ser. 6, vol. i.	1904, p. 3.	*Specie Orbignyane di Foraminiferi.*
9.	,, vol. ii.	1905, p. 59.	,, *di Miliolidi.*
10.	,, vol. iii.	1906, p. 61.	,, *di Rotalidi.*
11.	,, vol. v.	1908, p. 41.	,, *di Nodosaridi*, etc.

Rend. Acc. Sci. Ist. Bologna :—

12.	N.S., vol. ii.	1897, p. 9.	*Sabbie Bolognesi.*
13.	,, vol. vii.	1903, p. 142.	Globigerine.
14.	,, ,,	,, p. 139.	Amphistegine.

Rivista Ital. Paléont. :—

15.	Vol. iii.	1897, p. 13.	Clavulina.
16.	Vol. v.	1899, p. 23.	Biloculina.
17.	Vol. vii.	1901, p. 104.	Textilaria.
18.	Vol. viii.	1902, p. 11.	Polymorphina.
19.	,,	,, p. 44.	Textilaria.

APPENDIX J.

The Final Conclusions of Félix Dujardin.

No apology is needed for a short recapitulation of the final conclusions of Dujardin, recorded in the larger work cited in this Memoir (p. 41), regard being had to the position which he occupies with regard to the history of the Foraminifera. Recognizing, as he was the first to do, that their zoological place was among the lowest forms of creation he included them in his "Second Order. Rhizopoda. Asymmetrical Infusoria; 2nd Family. *Amœbæ.* Naked animals, crawling, of continually varying form. 3rd Family. *Rhizopoda.* Animals either crawling or fixed; secreting a more or less regular shell or test, from which protrude continually varying expansions."

It must be remembered that the period covered by the early work of Dujardin was the era of the invention of the Achromatic Microscope, and the revelations afforded by the new instruments seemed to contemporary biologists to open up a vista capable of the widest and hitherto undreamed of expansion. Thus Dujardin says in his Introduction (p. vii), "Quoique le Microscope par les perfectionnements qu'il a récus depuis quinze ans soit devenu en quelque sorte un instrument nouveau et inconnu de nos prédecesseurs, nous sommes loin de croire qu'il soit arrivé au terme de ses perfectionnements possibles," and after some anticipations of possible progress he concludes (p. viii), "Comme celui qui bâtit sur le sable mobile ou sur un sol inconnu, nous sommes donc exposé à voir notre œuvre, à peine édifiée, s'écrouler, ou perdre tout d'un coup sa valeur, par suite de telle découverte pressentie vaguement et qui doit multiplier un jour la puissance de notre vue." It was actuated by such reflections as this that Dujardin himself laboured at, and contributed not a little to, the improvement of the instrument.

Accordingly he commences his work with the statement that "the history of the Infusoria is entirely bound up in that of the Microscope." His mind was much exercised by the nature of the protoplasm to which he had given the designation "sarcode," and he observes (as others have observed and recorded in varying terms) on p. 25, "Nevertheless we are not justified in saying that, where the Microscope shows us only a homogeneous transparent substance, but endowed at the same time with movement and life, we must conclude with finality that neither fibres nor organs of any kind are present. . . . We must arrive at the conception of an ultimate expression of size at which a homogeneous substance is of itself contractile."[1] He divides the Rhizopoda of this third family (Foraminifères) into: (1) Free, e.g. Rotalia, Polystomella, and Cristellaria, of which the first has a test lined with an internal membrane, the two latter being entirely calcareous and per-

[1] We may compare this with a passage in Carpenter's "Mental Physiology," London (1874), p. 44, in which he says, after describing the behaviour of certain Foraminifera to which I have been bold enough to apply the term "purposive," "The apparent absence of a nervous system is doubtless to be attributed in many instances to the general softness of the tissues of the body, which prevents it from being clearly made out among them." (See also Journ. R. Micr. Soc. (1916), p. 138, in a paper in which I discussed this matter at some length.)

forate all over; and (2) Fixed, e.g. Rosalina (Truncatulina) Planorbis, and perhaps Polytrema ("ancien *Millepora rubra* que d'après des observations non vérifiées depuis 1834 je suis porté à ranger parmi les Rhizopodes)." (See p. 41.)

He points out (p. 240), after referring to d'Orbigny's original attribution of the animals to the Cephalopoda, that later authors (see p. 42) have still persisted in arguing from the complexity of the test, against the observations which reveal in these Rhizopoda the simplest possible organization. He refers to d'Orbigny's establishment of Families founded on the arrangement of the chambers, and of Genera founded on the presence and position of an aperture, which, however, he says he has not been able to make out as clearly as d'Orbigny (p. 243). He points out that he was the first to see Foraminifera in their correct light, that he was the first to decalcify them, and that he found them living on algæ and attached to the "asperities" of molluscan shells, the marine forms being generally visible to the naked eye (1 mm.), the living shells being often red or yellow, but the empty shells being white.

At p. 252 he gives a systematic description of all the species known to him, beginning with *Gromia oviformis*, of which he gives a very complete and elaborate account, most of which I have had the good fortune to confirm in my observations at Selsey. He describes their climbing the sides of his tanks and "swimming" on the surface of the water, the protrusion and formation of the pseudopodia, and their sensitiveness when touched by passing animals, their tenacity and extensile properties revealed when they are disturbed or shaken.

He gives an equally complete account of "Miliola," figuring an apparently biloculine form for which he proposes the name *Miliola vulgaris*,[1] which may, however, be a very rotund *Miliolina seminulum*. He describes (p. 258) Vertebralina as having been found by him at Toulon, which he justly observes "is very nearly related to the Miliolæ"; Cristellaria as common in the Mediterranean (see, however, d'Orbigny's observation (p. 42, *ante*), that this was probably the common Mediterranean form Peneroplis). He describes the equitant chambers of Polystomella revealed by decalcification.

His Plate I. (repeated from Bibl. V.) gives finely drawn and coloured figures of Polystomella and of the Miliolid with the pseudopodia fully extruded. He says that he has not observed Rotalia, Rosalina, and Planorbulina alive, but that he is satisfied that all parts of the shell are occupied with the sarcode body, as is the case with Polytrema.

Finally, he refers to a few fossil forms, regarding "Siderolites" (i.e. Calcarina) from the Maastricht chalk as a Rhizopod, but he is not satisfied of the foraminiferal nature of Nummulites, "Oryzaria" (i.e. Alveolina), Nodosaria, and some of the other d'Orbignyan species.

It may be mentioned in conclusion that years after he was in some doubt as to the Rhizopodal nature of many of the d'Orbignyan species as "we find appended to the names of several of those described by him in the 'Dictionnaire Universelle d'Histoire Naturelle' (e.g. Nonionina, Nummulites, and Rotalia), the abbreviation *Moll ?* as well as *Foram*."[2]

[1] This name had already been "occupied" by d'Orbigny for one of his species.
[2] XVII., p. 7.

Bibliography.

I. A. d'Orbigny.—Tableau Méthodique de la Classe des Céphalopodes précédé d'une Introduction par M. de Férussac. Ann. Sci. Nat. vii. (1826) pp. 96–169. Suite, "Foraminifères," pp. 245–314, Atlas (pls. x–xvii).

II. F. Dujardin.—Observations nouvelles sur les Céphalopodes Microscopiques. Ann. Sci. Nat. (Zool.), ser. 2, iii. (January 1835) pp. 108–9.

III. ——— Observations nouvelles sur les prétendus Céphalopodes Microscopiques. Ann. Sci. Nat. (Zool.), ser. 2, iii. (June 1835) pp. 312–314.

IV. ——— Observations sur les Rhizopodes et les Infusoires. Comptes Rendus de l'Acad. des Sci. (November 1835) pp. 338–340.

V. ——— Récherches sur les Organismes Inférieures. Ann. Sci. Nat. (Zool.), ser. 2, iv. (December 1835) pp. 343–377.

VI. ——— Suites à Buffon. Histoire Naturelle des Zoophytes. Infusoires. Paris, 8vo, 1841.

VII. A. d'Orbigny.—In: Ramon de la Sagra. Histoire physique, politique et naturelle de l'Ile de Cuba. Foraminifères. Paris, 8vo, 1839. (With an Atlas of 12 pls. fol.)

VIII. ——— In: P. Barker-Webb and S. Berthelot. Histoire Naturelle des Iles Canaries. 105 Livraison. Foraminifères. Paris, 1839 (fol. 3 pls.).

IX. ——— Voyage dans l'Amérique Méridionale, v. part 5. Foraminifères. Paris, 1839 (fol. 9 pls.).

X. ——— Mémoire sur les Foraminifères de la Craie Blanche du Bassin de Paris. Mem. Soc. Géol. France, iv. 1841. Mem. I., pp. 1–51 (4 pls.).

XI. ——— Mollusques vivants et fossiles, Paris, 1845, 8vo.

XII. ——— Foraminifères Fossiles du Bassin Tertiaire de Vienne (Autriche) découverts par S. E. le Chev. Joseph de Hauer (French and German). Paris, 1846, 4to.

XIII. ——— Article: "Foraminifères" in "Dictionnaire Universelle d'Histoire Naturelle, dirigé par Charles d'Orbigny," v. Paris, 1844 (? 1845) pp. 662–671.

XIV. ——— Cours Elémentaire de Paléontologie et de Géologie Stratigraphiques. Paris, i. 1849; ii. 1852.

XV. ——— Prodrome de Paléontologie Stratigraphique Universelle des Animaux Mollusques et Rayonnés, faisant suite au Cours Elémentaire de Paléontologie, etc. Paris, i. and ii. 1850; iii. 1852.

XVI. Gaudry, A.—Alcide d'Orbigny, ses voyages et ses travaux. Révue des deux Mondes, xix. (1859) pp. 816–847.

XVII. W. B. Carpenter, W. K. Parker, and T. Rupert Jones. Introduction to the Study of the Foraminifera. London, Ray Society, 1862, fol.

XVIII. W. K. Parker and T. Rupert Jones. On the Nomenclature of the Foraminifera. Part X. The species enumerated by d'Orbigny in the "Annales des Sciences Naturelles," vii. 1826. Ann. Mag. Nat. Hist., ser. 3, xii. (1863) pp. 429–441.

XIX. W. K. Parker and T. Rupert Jones. On the Nomenclature of the Foraminifera. Part X. (continued). III. The Species illustrated by Models. Ibid., xvi. (1865) pp. 15–41 (pls. i–iii).

XX. ——— Part XIV. IV. The Species founded upon the Figures in Soldani's "Testaceographia ac Zoophytographia." Ibid., ser. 4, viii. (1871) pp. 145–179, 238–266 (pls. viii–xii).

XXI. P. Fischer.—Notice sur la vie et les travaux d'Alcide d'Orbigny. Bull. Soc. Géol., France, ser. 3, vi. (1878) pp. 434–53.

XXII. C. de Labonnefon.—Les d'Orbigny, Naturalistes (1770–1856). Les Contemporains, No. 718, Paris, n.d. (1906) p. 16 (woodcuts).

XXIII. C. Basset.—Foraminifères de la Société des Sciences Naturelles de la Charente Inférieure. Soc. des Sci. Nat. de la Charente Inf. Annales de 1884; La Rochelle (1885) pp. 153–173 (photographic plate).

XXIV. E. Beltremieux.—Le Naturaliste d'Orbigny à Esnandes. Ibid., Annales de 1888; La Rochelle (1889) pp. 353–56 (pl.).

XXV. K. A. von Zittel.—History of Geology and Palæontology to the End of the Nineteenth Century. Translated by M.M. Ogilvie-Gordon. London, 1901.

XXVI. E. Heron-Allen and A. Earland.—The Recent and Fossil Foraminifera of the Shore-Sands at Selsey Bill, Sussex. Journ. Roy. Micr. Soc., London, 1908–1911.

XXVII. ——— The Foraminifera of the Kerimba Archipelago (Portuguese East Africa). Trans. Zool. Soc., London, xx. (1915) part 1 (1914) pp. 363–90 (pls. xxxv–xxxvii); part 2 (1915), pp. 543–794 (pls. xl–liii).

XXVIII. E. Heron-Allen.—Contributions to the Study of the Bionomics and Reproductive Processes of the Foraminifera. Phil. Trans. Roy. Soc., London, ser. B, ccvi. pp. 227–279 (pls. xiii–xviii), London, 1915.

Note *to page* 9.—It was difficult to resist becoming a little carried away by the mention of the Conventionnel Billaud-Varennes. Not only was he born at La Rochelle, where his father was an *avocat* in an excellent position, but it was to La Rochelle that he was brought, after a terrible journey, on which he narrowly escaped with his life from the fury of the populace at Orleans, Tours, Poitiers, and Niort, on the 12th April, 1795, after the reaction of the 9th Thermidor. His father and mother met him at the Port, and spent a few hours with him before his incarceration on the Ile d'Oléron, preparatory to his embarkation for Cayenne. From thence he made a tragic progress, transferred in turn to Sinnamary—where even his political colleagues, exiled thither in 1797, refused to be associated with him—and to Makourin, in French Guiana. Here he refused the amnesty granted to political prisoners in 1800. His wife, Angélique Doye, whose adventures after the transportation of Billaud-Varennes is a romance in itself, came to La Rochelle in 1796, anxious to join him in his exile in Guiana, but Billaud-Varennes would not consent to her making the journey. He had taken to himself a young negress of sixteen years, who became his faithful companion until his death. They moved from one plantation to another, and in May 1816 they went to the United States, living in turn in great hardships at Newport and New York; and in September of the same year they went and settled in San Domingo, the ancestral home of the d'Orbignys. It was only here that he abandoned "the terrible lion's mane"—the yellow peruke that he had always worn, even in exile—and it was here that he died on the 13th June, 1819. The curious interweaving of the lives of Billaud-Varennes and d'Orbigny *père* in La Rochelle and San Domingo has always impressed me vividly. Angélique Doye died in 1815; the negro wife of Billaud-Varennes was still living in extreme old age at Port-au-Prince in 1874.

SUMMARY OF CURRENT RESEARCHES

RELATING TO

ZOOLOGY AND BOTANY

(PRINCIPALLY INVERTEBRATA AND CRYPTOGAMIA),

MICROSCOPY ETC.*

ZOOLOGY.

VERTEBRATA.

a. Embryology.†

Gonads in Relation to Secondary Sex-characters of Birds.‡ — H. D. Goodale has experimented with Rouen ducks, brown leghorns, and cross-bred birds, observing the changes in plumage, etc., that follow gonadectomy. 1. The plumage of the orchidotomized male is altered comparatively little: some feathers grow somewhat longer, but otherwise they are the same as in the unaltered male. In contrast, the plumage-changes of the ovariotomized female are extensive, in respect to shape, size, colour and colour-pattern. The plumage approximates to that of the normal male. 2. As to head-furnishings, the capon's comb and wattles remain of infantile type. In the castrated hens the comb becomes very large and male-like in some, while in others it remains comparatively small. As yet there is no clear evidence of the causes of this difference. 3. All the capons reported on by Goodale have well-developed spurs. In all the castrated hens in which the male plumage also developed there were well-developed spurs, while in many of those in which the assumption of male plumage was partial or temporary the spurs started to grow. Several times they continued to grow after the plumage reverted, and though they did not grow quite as long as those in which the removal of the ovary was complete, they were otherwise similar. Apparently, the dependence of the spurs upon the internal secretion is relatively slight; the inhibition exerted in the female upon the development of the spurs is so slight that once develop-

* The Society are not intended to be denoted by the editorial "we," and they do not hold themselves responsible for the views of the authors of the papers noted, nor for any claim to novelty or otherwise made by them. The object of this part of the Journal is to present a summary of the papers *as actually published*, and to describe and illustrate Instruments, Apparatus, etc., which are either new or have not been previously described in this country.

† This section includes not only papers relating to Embryology properly so-called, but also those dealing with Evolution, Development, Reproduction, and allied subjects.

‡ Carnegie Inst. Washington, Publication No. 243 (1916) pp. 1–52 (7 pls.).

ment starts the hormone is not always able to check it. Some strains of leghorns and minorcas produce a large percentage of spurred female offspring. 4. Castrated ducks of both sexes showed no change in voice, but castrated fowls are disinclined to give voice to any kind of sound. Capons can utter all the sounds of which the cock is capable, but they rarely do so. 5. As far as Goodale's observations go, castration with one exception has not influenced the moult of the capon. On the other hand, castrated ducks lose the power of developing the summer plumage. 6. Castration is without influence on the colour of the male duck's mandible, but ovariotomy results in the disappearance of certain pigments from the mandible of the female. 7. Completely castrated individuals of all kinds are on the whole negative in behaviour as compared with normal adults. The behaviour of castrates corresponds rather closely to that of young birds shortly before they become mature. The birds eat, drink and move about rather quietly.

Male characters, such as spurs, large comb and wattles, and a "neck ring" in ducks, sometimes occur in otherwise normal females. Instances of the occurrence of female characters in males, strictly comparable to those just referred to, are uncommon or wholly lacking. The only character of this sort among capons is the brooding instinct. Some female-like characters in males are juvenile characters. It is probable that while some secondary sex-characters are absolutely dependent on the internal secretion of the gonad, others are partially, at least, independent. Hen-feathered males illustrate juvenile, rather than female characters of plumage. Neither the assumption of male plumage by the female nor the development of the accessory reproductive organs need be considered evidence that the female is a suppressed hermaphrodite, because the secretion of the ovary clearly controls their development. On the other hand, it is clearly proven that the female is a suppressed *pseudo*-hermaphrodite.

The influence exerted by the gonads on the secondary sex-characters differs in different groups. In insects the secondary sex-characters are independent of the gonads. In certain Crustaceans the conditions are the reverse of those found in birds. In Mammals removal of the testes produces an effect very similar to that on the male bird, while the female undergoes little change in her secondary sex-characters.

On the whole, the relation between the gonads and the secondary sex-characters appears to be specific and not general. Although more striking, their relation is essentially of the same order as other morphogenetic secretions, such as that of the thyroid. Indeed, the morphogenetic activity of the gonads is by no means confined to the secondary sex-characters, but produces other well-known effects.

The three most important results are: 1. If the ovary of a domestic bird be removed completely, many of the secondary sex-characters of the male appear (and always of the male of the same race). Some individuals become nearly complete replicas of the male, others imperfect imitations of the male. 2. If the testes be removed, the majority of the secondary sex-characters of the male develop, though a few may remain in an infantile condition. 3. Castrated drakes lose the power of developing the summer plumage.

Growth in Length.*—The late Richard Assheton delivered three lectures in 1913 on the growth in length of the Vertebrate embryo, which have now been published, along with a reprint of a paper on the mechanics of gastrulation. Anatomical observation and experiment point to the conclusion that in all anamniote chordates the growth in length of the embryo is due to the origin of a special area of cell-production round the lips of the blastopore which converts the spherical form of the gastrula into the cylindrical form of the later embryo. Since this area comes into being only after the gastrula is formed, we may recognize two regions in the later embryo. One of these, the protogenetic region, is the direct result of the segmentation of the ovum culminating in the gastrula, and having the general character of a radially symmetrical form, and this on the whole is to be identified with the cœlenterate phase of evolution. The other region, called deuterogenetic, is produced by proliferation of the lips of the gastrula mouth.

The part formed from the protogenetic region includes the fore-brain, probably also the mid-brain, the mouth, and possibly the hind-brain as far as the origins of the fifth and eighth nerves, the branchial region and heart, and probably much of the gut. The part formed from the deuterogenetic region comprises the remainder of the hind-brain, the spinal cord, the tail, the whole of the metamerically segmented mesoderm, and *in the craniates* the renal organs. There is much evidence to show that in the craniate chordates the actual germ-cells are protogenetic in origin, but migrate during development into the deuterogenetic region and here undergo their maturation, eventually finding their way to the exterior by means of the deuterogenetic channels of the cœlom or renal apparatus.

The same relations between the two regions probably hold good for the amniotes, though in them experimental evidence is obtained less easily.

Having attained the stage of a cœlenterate, the gastrula may take diverse courses. The whole deuterogenetic centre might continue active, or it might cease to be active almost as soon as formed, or a portion might remain for a longer time active while the rest dies out earlier.

It may be suggested that deuterogenesis in the embryo is a geometrical consequence following gastrulation (which may perhaps also be regarded as a necessary culmination of protogenesis). If so, these consequences of embryonic development must have had their effect upon evolution. For instance, one of the first effects of deuterogenesis must be in many cases a tendency to close the blastopore.

Now, clearly, in evolution, to close the only entrance to the gut would be fatal. Therefore the necessity to live must have opposed the geometrical tendency. The warring of the two tendencies may well have given the impetus in evolution which has led to the very varying fates of the blastopore in the different groups, and the consequent relation of the main axis to the plane of the blastopore.

The two phenomena, the difference in the fate of the blastopore,

* Growth in Length : Embryological Essays. Cambridge: (1916) xi and 104 pp. (42 figs.).

and the difference in the fate of the deuterogenetic centre, are of fundamental importance in an attempt to understand the relationship of the chief phyla. The experimental and anatomical facts point to the conclusion that the main axis of the Vertebrata is at right angles to the plane of the blastopore or cœlenterate mouth.

Origin of Sex-cords and Spermatogonia in Male Chick.*—Charles H. Swift finds that the true sex-cords or seminiferous cords originate from the germinal epithelium during the sixth and seventh days of development, and are the result of localized activity of the epithelium. Nearly all the primordial germ-cells present in the germinal epithelium are carried down into the seminiferous cords, but they play only a passive role, for at this time they show no evidences of cell-division. The sex-cords remain attached to the germinal epithelium for only a short time, and continue to grow, after formation of the albuginea, as a result of division of the peritoneal cells.

At the end of the seventh day of development the sex of the individual can be easily told, for in the male the gonads are of nearly equal size, while in the female the left gonad is much the larger. In the male the germinal epithelium remains thin after the formation of the sex-cords and contains very few primordial germ-cells, while in the female the epithelium of the left gonad or ovary continues to be thick and contains many primordial germ-cells. During the eighth and ninth days of development the gonads increase slowly in size and the thin sex-cords make up most of the volume of the testes. They are separated from one another by a thin layer of stroma, and have a definite orientation from germinal epithelium obliquely down towards the Wolffian body. When the embryo is eleven days old the stroma begins to increase in quantity and the seminiferous cords commence to meander and to anastomose with each other.

Up to the thirteenth day the primordial germ-cells in the sex-cords do not divide. At this date they divide actively for four days. The primordial germ-cells give rise to spermatogonia, which differ from them in having a mitochondrial crescent (comparable to the "yolk-nucleus" in oocytes and young oogonia). The interstitial cells appear in the stroma on the thirteenth day, but reach their greatest development during the seventeenth day. They are simply differentiated stroma cells, since they do not divide and transitional forms can be seen.

Cavities begin to appear in the network of seminiferous cords during the twentieth day, arising by liquefaction of axial cells. At this date the spermatogonia are found against the basement membrane, with the nucleus towards the central axis of the cord, and the mitochondrial crescent near the basement membrane. They probably reach this position by amœboid migration. The elongated cells between the spermatogonia are derived from the peritoneal cells of the seminiferous cords. The primordial germ-cells give rise to the spermatogonia, and the cœlomic cells of the germinal epithelium produce the supporting cells of the seminiferous tubule.

* Amer. Journ. Anat., xx. (1916) pp. 375–410 (6 figs.).

Development of Bird's Lung.*—W. A. Locy and Olof Larsell complete their detailed account of the development of the bird's lung. Using the method of air-injection they were able to carry the embryonic bronchial tree to later stages than those previously sketched. They attach considerable importance to the dorsobronchi and also to the laterobronchi, on account of the part they play in helping to form the network of the bronchial circuits. The interclavicular air-sac actually arises from four separate moieties, two from each lung. Much importance is attached to the "recurrent bronchi," recognized by Schulze and Juillet, which spring from the air-sacs and grow back into the lungs, where they establish numerous connexions with the bronchial branches. The air-sacs are thus to be regarded, not as terminal sacs, but as expanded reservoirs on the course of the bronchial circuits.

Influence of Low Temperature on Development of Fundulus.†
W. E. Kellicott finds that the eggs of this fish, if subjected immediately after fertilization to the temperatures of the ordinary refrigerator, often develop abnormally when returned to the laboratory temperature. The abnormalities cover a very wide range and may affect any of the external features. Similar treatment after the embryo has been well-formed leads to similar results, but with less frequency. The effects observed take the form of irregularities in the distribution and combinations of both nuclear and cytoplasmic substances, and in the formation of cell-walls. The results resemble those known to follow chemical treatment and heterogeneous hybridization. It is suggested that the cause of abnormal and monstrous development, here and in other similar instances, is to be found in a disturbance of the normal organization of the ovum, as expressed by the unusual characters and distribution of the differentiated materials of the egg-protoplasm. This "disorganization" hypothesis is regarded as affording a more satisfactory interpretation than the current "nutrition" hypothesis of the cause of teratogeny.

b. Histology.

Modifications of Mitochondria.‡—W. J. M. Scott shows that mitochondria are the first constituents of the acinus cell of the pancreas to show pathological change in phosphorus poisoning. They lose their filamentous form, become shorter and thicker, and their blob-like swellings, which are so characteristic in the normal pancreas, completely disappear. Then follows the stage of agglutination in which the mitochondria collect in large compact clumps. The mitochondria in these agglutinated masses fuse to form droplets possessing the characteristic properties of lipoid.

Variations of Mitochondria in Nerve-cells.§—Norman C. Nicholson finds that there are qualitative differences in the mitochondrial content

* Amer. Journ. Anat., xx. (1916) pp. 1–44 (22 figs.).
† Amer. Journ. Anat., xx. (1916) pp. 449–82.
‡ Amer. Journ. Anat., xx. (1916) pp. 237–52 (1 pl.).
§ Amer. Journ. Anat., xx. (1916) pp. 329–48 (2 pls.).

of certain types of nerve-cells in the brains of white mice. Filamentous mitochondria are commonest, but there are also rod-like, granular, and block-like forms. There is also, in the majority of cases, a variation in the form of mitochondria in the same cell. They are usually more granular near the nucleus than peripherally; they are invariably rod-like or filamentous in the processes. They occur not only between the Nissl bodies (as is generally believed), but also embedded in them. In different kinds of nerve-cells the mitochondria differ microchemically; thus in some cases they are more resistant than in other cases to fluids containing acetic acid.

Text-book of Histology.*—H. E. Jordan and J. S. Ferguson have prepared a text-book of histology which aims at relating the facts of structure to those of function, and at illustrating the generalizations which unify the whole subject. The minute structure of all the systems is described, and there is a long chapter on technique.

c. General.

Structure of Feathers and their Taxonomic Significance.†—Asa C. Chandler has enquired into the taxonomic value of peculiarities in feathers. A detailed account is given of a typical feather. Under plumules are discussed unspecialized plumules, powder-down, oil-gland feathers, and nestling feathers. Filoplumes are then discussed and the various kinds of contour feathers—remiges, rectrices, unspecialized contour feathers, ornamental plumes, ear coverts, facial bristles and eyelashes, and facial ruffs. In connexion with colour, particular attention is paid to "isotely" or the attainment of a similar result in different ways. An interesting point is that when pigment is absent in albinos, the structural specialization so frequently involved in the production of colour effect is also absent.

The author gives an account of the peculiarities of feather-structure in the various orders and sub-orders of birds—a big undertaking. It appears that the structure of the feathers has great taxonomic value, much more than scales on fishes or hair on mammals. Importance attaches especially to the aftershaft, the rami, the distal barbules of the remiges, and the degree and manner of simplification of the barbules of the body-feathers. A study of the minute structure of feathers is shown to be of very striking corroboratory value in reference to conclusions as to the relationships of orders, and a phylogenetic tree is submitted.

Evolution of Lizards.‡—G. A. Boulenger discusses the lines of evolution which have led from *Lacerta* and *Nucras*, occurring in Oligocene and Miocene, to derivative genera like *Latastia*, *Acanthodactylus*,

* A Text-Book of Histology. New York: (1916) 800 pp. (594 figs.). See also Trans. Amer. Micr. Soc., xxxv. (1916) pp. 159–60.

† Univ. California Publications (Zool.) xiii. (1916) pp. 243–446 (25 pls. and 7 figs.).

‡ Trans. Zool. Soc., xxi. (1916) pp. 1–104 (7 pls. and 12 figs.).

Psammodromus, etc. The great modifications include a reduction and disappearance of teeth on the palate, a flattening and weakened ossification of the skull with elongation of the rostrum and other changes, a disappearance of the parietal foramen, a disintegration of the head-shields and other changes in the head-scales, the formation of a transparent disk in the lower eyelid and ultimate fusion of the lower with the upper, the formation of a denticulation or a fringe of scales in front of the ear-openings, a reduction or increase in the size of the scales on the body and tail, a decrease in the imbrication of the shields on the belly, a reduction and loss of the collar, a lengthening and compression of the digits accompanied by an increase in the number of inferior lamellæ, a multiplication of the scales round the digits and other changes, a lengthening of the tail perhaps accompanied by an increased fragility, a modification of the patterns of markings, and an assumption of vivid colours. Starting from striation there was an evolution on the one hand to "ocellation" (in longitudinal, irregular, or transverse bars), and on the other hand to spotting (longitudinal, irregular), reticulation, and barring.

Anatomy of Blacksnake.*—W. H. Atwood gives an account of the structure of the viscera of *Zamenis constrictor*, to which we refer mainly on account of its disclosure of variability. "If the variability is as great in all snakes as it is in the blacksnake, the accepted description will prove to be very inadequate, if not misleading." In a number of ways the visceral structure of the blacksnake differs from what has been described elsewhere. The left lung, inadvertently called the right (p. 34), is about one-fourth of an inch long and nearly the same diameter, while the right lung is some 5–6 inches long. The left lung varies in size and shape in different specimens. It lies just beneath the front of the heart and is connected with the trachea by a pore. It is supplied with blood from the vessels of the right lung. The left pulmonary artery and vein are absent.

Hæmoglobin in Invertebrates.†—Isabella Leitch has made an experimental study of *Planorbis corneus* and larvæ of *Chironomus* in order to discover the precise function of the hæmoglobin. It makes available, by its power of binding oxygen chemically, a quantity of oxygen sufficient for the needs of the animals at oxygen tensions so low that the necessary amount is not supplied by physical solution. In *Planorbis* the mode of action is as in Vertebrates; it depends not at all on a power of "storing" oxygen, but wholly on the constant circulation of a current of alternately oxidized and reduced blood between the lung and the tissues. In *Chironomus* it is even simpler, but quite similar, namely, the constant binding of oxygen at the surface of the body and the constant giving up of it in the interior—a continuous mixing and interchange of oxidized and reduced blood kept in motion by the beating of the heart; and the only difference is that in each case

* Washington Univ. Studies, iv. (1916) pp. 1–38 (21 figs.).
† Journ. Physiol., l. (1916) pp. 370–9.

the hæmoglobin is present in just such a solution as enables it to utilize these low tensions of oxygen to which the animal is subjected in a habitat of badly aërated water.

Sesamoid Articular Bone in Fishes.*—E. C. Starks has made an extensive study of the occurrence of the sesamoid articular, a small bone on the inner surface of the articular of fishes. It gives attachment to a stout tendon from the adductor muscles of the mandible. It was first noticed by Cuvier. It occurs in every group that is more highly specialized than the primitive Clupeoid fishes. It is always in relationship with Meckel's cartilage, and usually in very close association with it. It often differs within a genus, and is of no use in the taxonomy of groups larger than species.

INVERTEBRATA.

Mollusca.

α. Cephalopoda.

Spermatophores of New Cephalopod.†—Anna Vivanti discusses *Charybditeuthis maculata*, which she has previously established ‡ as a new genus and species. It was found at Messina, and seems to be an abyssal form accidentally brought to the surface. The tentacles bear photogenic organs. In the visceral sac of the specimen (a female) there was a peculiar structure interpreted as a sponge. This turns out to be a packet of spermatophores with an enormous number of spermatozoa. It has been described by Mortara.§

γ. Gastropoda.

Two Generations of Nudibranchs in the Year.‖—L. P. W. Renouf finds that *Lamellidoris bilamellata* (Linn.) breeds twice during the first year of its existence and only once afterwards, and that the same is probably true of *Archidoris tuberculata* (Cuvier). All the winter to spring specimens and their spawn-spirals are large, the summer to autumn specimens and spawn-spirals are small.

Arthropoda.

α. Insecta.

Bee Disease.¶—John Anderson reports some experiments which point to the conclusion that *Nosema* is not the cause of Isle of Wight

* Leland Stanford Univ. Publications, Univ. Series, 1916, pp. 1-40 (15 figs.).
† Rend. Roy. Ist. Lombardo, xlviii. (1915) p. 233-7.
‡ Arch. Zool. Ital., vii. (1914) pp. 55-79.
§ Rend. Accad. Lincei, xxiv. (1915).
‖ Proc. Roy. Phys. Soc. Edinburgh, xx. (1916) pp. 12-15.
¶ Proc. Roy. Phys. Soc. Edinburgh, xx. (1916) pp. 16-22.

disease in bees. The parasite is not always present in "crawling" bees; its presence does not always produce the disease; stocks heavily infected may live long.

John Anderson and John Rennie* give a detailed account of observations and experiments bearing on Isle of Wight disease in bees. So far they have been unable to recognize any causal relation between the presence of *Nosema apis* and the disease. They have found the parasite present over prolonged periods in healthy stocks, while they were unable to find it in other stocks in the apiary, nor did Isle of Wight disease spread under these conditions, although various races of bees were present. Deliberate infection of a stock with *Nosema* did not produce the disease. In numerous cases on Deeside the disease occurred, but the parasite could not be found. The parasite is present in many healthy bees. It may be a contributing factor, favouring in certain cases the development of the disease, but the facts do not point to its being the essential factor. Isle of Wight disease is probably infectious and associated with a parasite, but it does not seem to develop without the coincidence of other and at present unknown factors. The disease is not necessarily conveyed by mere contact with contaminated hives or combs, or by feeding upon contaminated stores.

Maturation and Fertilization in Platygaster.†—F. Silvestri has studied the maturation, fertilization, and early development of *Platygaster dryomyiæ* Silv., a Proctotrupid Hymenopteron. The first embryonic cell is to be distinguished from an adjacent nucleus which is due to a fusion of the nucleus of the proximal half of the first polar body with that of the second polar body. Round about the first embryonic cell, the fused nuclei alluded to, and the nucleus of the distal half of the first polar body, there is the rest of the ooplasm, the polar part of which forms the trophamnion. What Silvestri has observed in *Platygaster* confirms what he has previously described in various parasitic Hymenoptera of the family Chalcididæ.

Development of Hive-bee.‡—J. A. Nelson has given a full account of the development of this type, and his work will also serve as an introduction to the study of the development of insects in general. The total period normally required for the development of the egg is seventy-six hours. Cleavage occupies fourteen to sixteen hours, blastoderm formation fourteen to sixteen hours; formation of the mesoderm, rudiments of mesenteron and embryonic envelope twelve to fourteen hours; and the remainder of development thirty-two to thirty-six hours. The bee-embryo has twenty-one segments including the telson; no abdominal appendages were seen; separate cœlomic sacs are not present, the somatic and splanchnic layers of mesoblast being continuous longitudinally throughout the trunk; no trace of maxillular segment was seen.

* Proc. Roy. Phys. Soc. Edinburgh, xx. (1916) pp. 23–61 (1 pl.).

† Rend. Accad. Lincei Roma, xxv. (1916) pp. 121–8 (2 figs.).

‡ The Embryology of the Honey-Bee. Princeton and London: (1916) 282 pp. (6 pls. and 95 figs.). See also Journ. Zool. Research, i. (1916) pp. 38–9.

Dipterous Enemy of Aphides.*—John J. Davis gives the life-history of *Aphidoletus meridionalis* Felt, a cecidomyid fly the larva of which is an enemy of many species of aphides. The fly is remarkably prolific, and each larva may destroy dozens of aphides; it is therefore an insect of great economic importance. The author found it destroying large colonies of *Aphis setariæ* and *Hyalopterus pruni* on plum.

The eggs are elliptical oval, chrome-yellow in colour, and measure about 0·3 mm. in length by 0·1 mm. in width. They are laid in clusters of from one to twelve on foliage amongst a colony of aphides, or on the back of the aphis, so many as seven having been noted on a single aphis. The female lays more than 100 eggs. On hatching the larva attacks an aphis by piercing its body from beneath, and after sucking the body-fluid leisurely moves to another. After it becomes one-third grown it usually punctures the aphis at one of the articulations of the legs. When fully mature it spins a loose cocoon of silk, attaching it to a leaf, or descends to the ground and spins it at or near the surface. The larva very shortly pupates; the pupa is 2 mm. long; the pupal stage varies in duration from six to nine days. The adult is a frail midge, the male being 1·4 mm. long and the female 1·8 mm. Egg-laying continues for about ten days, the midge living about fourteen days. The life-cycle from egg to adult varies from fifteen to twenty-nine days in length, and there are at least six generations annually.

Experiments on Mangold-fly.†—Alfred E. Cameron finds that *Pegomyia hyoscyami* reared on belladonna will oviposit and complete its life-history on mangolds if belladonna be absent. Specimens reared on mangold-leaves did not oviposit on those of the nearly allied sugar-beet. He also finds that *P. bicolor* reared on dock does not oviposit and complete its life-history on mangold or sugar-beet.

Braconid Parasitism.‡—Timberlake finds that some beetles may be thoroughly parasitized by the common Braconid, *Dinocampus americanus*, without fatal results. The larva of the parasite may attain full size and escape, yet the recovery of the beetle may be complete. The vital organs do not seem to be injured, but the depletion of the fatty body or the presence of the exit aperture is sometimes fatal. Yet experiments show that successive parasitism may occur, and more than one generation of parasite pass out from one and the same host.

Life-histories of Leaf-hoppers.§—Herbert Osborn gives an account of the eggs and nymphs of various leaf-hoppers (Jassidæ) injurious to grass and grain crops in Maine, and discusses methods of controlling the pests.

Setal Pattern of Caterpillars.‖—A. Schierbeek concludes that a far-reaching correspondence of arrangement obtains between the setæ,

* Journ. Agric. Research Washington, vi. (1916) pp. 885–8 (1 pl.).
† Bull. Entomol. Research, vii. (1916) pp. 87–92 (2 figs.).
‡ Canadian Entomologist, xlviii. (1916) pp. 89–91. See also Trans. Amer. Micr. Soc., xxxv. (1916) pp. 145–6.
§ Maine Agric. Exper. Stat., Bull. No. 248 (1916) pp. 53–80 (13 figs.).
‖ Proc. k. Akad. Wetensch. Amsterdam, xix. (1916) pp. 24–38.

the tubercles (eminences with one seta or several setæ), the verrucæ (warts with many setæ), the scoli (prominent spines), and pigmental spots. He regards all these integumentary structures as homologous. Homogeneous diffusion of setæ and their total absence are both secondary changes. A description is given of the type of arrangement which occurs on the abdominal segments of most caterpillars in the first instar. From this fundamental type all the others may be deduced.

Wing-markings in Hepialidæ.*—J. F. van Bemmelen has been led to the conclusion that the colour-pattern of the wings of Lepidoptera is to be looked upon as a mixture of components of different phylogenetic age, and consequently of unequal systematic value. In the primitive Hepialidæ the colour-pattern, in its original form as well as in its various modifications, occurs independently of generic differences. This means that phylogenetically the colour-pattern in all its manifestations is older than the division of the Hepialid family into genera, or, otherwise expressed, that the whole complex of modifications of the wing-design belonged to the inherent properties of the ancestry of the present Hepialids. This points to the assumption that in all species of the different genera the hereditary factors for all these colour-modifications are present.

Phylogeny of Wing-pattern in Lepidoptera.†—J. Botke directs attention to the close resemblance between the colour-designs of the hairy covering of the wings in Trichoptera and those of the scaly coat in Lepidoptera. The primitive colour-pattern of Lepidoptera has probably passed through the following stages in its evolution: 1. The membranous wings are provided with several transverse veins, lying between smoke-coloured margins. 2. The transverse connecting veins disappear, the margins persist and so form transverse colour-markings, the hairs on the wing-membranes acquire corresponding markings. 3. The hairs become transformed into scales, in which the colouring matter becomes accumulated, while the membrane loses it, being shut off from the light by the broadening of the scales.

We must regard the primitive colour-pattern of Lepidoptera as a relic of the more complex system of nervures which their ancestors possessed—a remnant of the numerous, colour-bordered transverse nervures which later on became obliterated. In some the ancestral condition has wholly vanished, in others it has been actually accentuated.

Gyandromorphic Specimens of Currant-moth.‡—L. Doncaster describes two peculiar forms of *Abraxas grossulariata*. The chief peculiarities of the first specimen are: (1) that though predominantly male, it had the *lacticolor* character, which from its parentage should be confined to females; and (2) that throughout the body the right side was male, the left imperfectly developed or tending towards the female

* Proc. k. Akad. Wetensch. Amsterdam, xviii. (1916) pp. 1255–65.
† Proc. k. Akad. Wetensch. Amsterdam, xviii. (1916) pp. 1557–63.
‡ Proc. Cambridge Phil. Soc., xviii. (1916) pp. 227–9.

type, with division of parts of the genital armature which are normally median. The internal genital organs were as far as is known imperfectly developed male organs.

The important features of the second specimen were: (1) the predominantly male character of its external organs, both genital armature (very imperfectly developed, however), and secondary sexual characters, combined with the pattern which should accompany the male sex (from the given parentage), though this was badly developed; and (2) the fact that the internal genital organs were ovaries, and contained a few quite well-developed eggs. In the light of these cases, Doncaster can explain certain exceptions to normal sex-limited inheritance previously believed to occur.

Life-history of Tiger-beetle.*—Lily H. Huie has studied the life-history and bionomics of *Cicindela campestris*. The grub burrows in sand-banks, in peat, or even in the borders of sandy roads. The head and jaws together with a semicircular plate on the prothorax serve to close the mouth of the hole; the hooks on the eighth segment behind the head serve to anchor the larva in its burrow when it springs forward at a passing insect, and to support it while waiting, for the burrow is deeper than the length of the body.

The approach of even the shadow of any creature big enough to be dangerous causes the larva to withdraw instantly. The burrow is always smooth-walled; the orifice is perfectly circular, with its edges smoothly rounded off; the diameter of a large burrow is 5–6 mm., the depth usually exceeds 3 inches; a full-grown larva measures rather under an inch in length. The larvæ observed in Argyllshire fed largely on blow-flies.

The male beetles are somewhat smaller than the females. The pairing occurs in May. Egg-laying was observed early in June, on sunny days. The egg is laid in a pit in the ground and this is carefully filled up. If the beetle be disturbed in laying and the egg get laid on the surface, she will turn round excitedly and devour her egg. Other beetles show no disposition to eat the dropped egg. The eggs are 2 mm. in length, oval, yellowish, coated with viscid substance. As they mature they become white and somewhat swollen. The behaviour of the larvæ and adults is carefully described. A typical life-history is made up as follows:—*Egg-stage*, about one month, say from mid-June to mid-July 1915. *Larval-stage*, nearly three years, from mid-July 1915 till June 1918. *Pupal-stage*, six or seven weeks, from early or mid-June till late July or early August 1918. *Adult-stage*: (1) within the pupal chamber, eight to nine months, from early August 1918 till near the end of April, 1919; and (2) from the emergence from the pupal chamber till egg-laying, about six weeks.

Respiratory System of Nepa cinerea.†—S. Maulik notes that the respiratory system of the nymph of this "water-scorpion" under-

* Proc. Roy. Phys. Soc. Edinburgh, xx. (1916) pp. 1–11.
† Journ. Zool. Research, i. (1916) pp. 41–58 (17 figs.).

goes remarkable changes rapidly and suddenly at the last moult. A description is given of the main tracheal system: the first three spiracles closed but functional in the adult (the second and third turned dorsally); the closed spiracles (fourth, fifth, nineteenth), which are entirely absent in the adult; the sieve-plate spiracles (sixth, seventh, eighth); the last segment of the abdomen; the anal siphon; the last spiracle—the only open one in the adult; and the respiratory structures in the thorax of the adult.

The adult breathe the atmospheric air. This is ordinarily taken in by the anal siphon, and through the siphonal spiracles it enters the main trachael trunks and their branches. The insect also keeps a supply of air under the wings and in the concavity of the mesothoracic pleuron. The respiratory system is a closed system of tubes with numerous ramifications with only two openings, viz. the last pair of spiracles at the base of the anal siphon. Of the rest of the system in the adult, only three small membranous surfaces—spiracles one, two, and three—can be in contact with the air. Under these given circumstances one inference is possible—the respiration is carried on by the diffusion of gases through the membranous covering of the thoracic spiracles.

In the nymph there are ten pairs of spiracles—all ventral, all open, and functional. There is no siphon, but there is a short concave projection from the abdomen instead. In this and in the two shallow grooves on either side of the raised mid-ventral region of the abdomen there is always a layer of air, collected at the surface and retained by a covering of hairs. Atmospheric air is essential to the nymph. The reasons for the change from the nymph respiratory arrangements to those of the adult may be that the exigencies of reproduction imply prolonged submersion, and that the insect during winter may have to remain a long time under a layer of ice.

Comparative Study of Chromosomes.*—Browne has studied the chromosomes in six species of Notonecta, and finds no definite correlation between the somatic and the chromosomic characters, except that the 14-chromosome species are the smaller, and the 13-chromosome species the larger. Each species has indeed a definite number and arrangement of chromosomes, but the status of a species in relation to its neighbours cannot yet be determined on this basis.

Genera and Species of Mallophaga.†—Launcelot Harrison has made a list of species of Mallophaga included in the genera *Pediculus* Linn, *Ricinus* Degeer, and *Nirmus* Hermann; a list of generic and sub-generic names, valid and invalid, used for Mallophaga; a provisional scheme of classification; a list of species and sub-species, valid and invalid, of Mallophaga. Of specific names, 1520 are treated as valid, and 875 as invalid. This list of the systematic nomenclature of the group will be of great value to investigators of Mallophaga.

* Journ. Morphology, xxvii. (1916) pp. 119–62. See also Trans. Amer. Micr. Soc., xxxv. (1916) pp. 141–2.
† Parasitology, ix. (1916) pp. 1–156.

The Louse and Disease.*—B. F. Cummings publishes an account of two species of louse parasitic on man, their life-history and habits, and the best methods of dealing with them. The third species, *Phthyrius pubis*, the crab-louse, is merely mentioned. Points of difference between the clothes-louse (*Pediculus humanus*) and the head-louse (*P. capitis*) are: the clothes-louse is larger, the smallest adults being larger than the largest examples of the other species; it is paler in colour, the body behind the head is broader, and the clefts which run in from the sides are deeper. The "gonopods," minute flap-like appendages at the posterior end of the lower surface of the female, become narrower towards the tip in *P. humanus* than in *P. capitis*. In the life-history it is important to note that, though the young louse normally emerges in eight days, temperature and other conditions may retard development, and the egg may hatch five weeks after it has been laid. Various vermicidal substances that have been tried during the war are discussed, and a mixture of naphthalene with 2 p.c. iodoform and 2 p.c. creosote (N.C.I.) and "Vermijelli" are recommended.

Ancestry of Insects.†—J. D. Tothill argues from embryological data and from primitive generalized forms like *Stenodictya* that winged insects or Pterygogenea are closely related to centipedes (Chilopods), and were possibly derived from an ancient stock in which the maxillipedes were not developed as jaws; also that the Chilopods were in turn derived (as Handlirsch suggests) from ancient generalized Trilobites. In the Trilobites practically all the segments were added after the egg stage; in the Chilopods most of the specialization by addition of segments takes place during the egg stages; in the Hexapods the segments arise only during the egg stage.

Insects of Rice-fields.‡—F. Supino has studied some of the aquatic insects that are of practical importance in the rice-fields near Milan. He deals particularly with the larvæ of *Stratiomys chamæleon* (Diptera), *Triænodes bicolor* (Neuroptera), and *Hydrocampa* (*Nymphula*) *nymphæata* (Lepidoptera).

Phoresis.§—E. Roubaud uses this term, suggested in 1896 by Lesne, in reference to the transporting role of some animals. Thus *Ateuchus laticollis* carries the fly *Limosina sacra*; while *Scarabæus indicus* and *S. gangeticus* carry *Limosina equitans*. In Equatorial and East Africa Roubaud has observed some Diptera of the group Borboridæ which have "phoretic hosts." Thus *Trichocypsela longiseta* is found on the coprophagous beetle *Pachylomera femoralis* Kirby, and *T. nasuta* on *Catharsius lux*, a Coprid. In the last case the fly remains attached to the beetle until it enters its burrow with its ball of dung. Then the fly moves off and lays its eggs in the dung, probably returning afterwards to its bearer. Another case described is that of *L. pallidicornis* Vill. which is borne by an Iulid. The fly lays its eggs in rotting vegetable

* Brit. Mus. Nat. Hist., Economic Series, No. 2 (1915) 16 pp. (4 figs.).
† Amer. Journ. Science, xlii. (1916) pp. 373–87 (8 figs.).
‡ Rend. R. Ist. Lombardo, xlix. (1916) pp. 108–14.
§ Bull. Soc. Zool. France, xli. (1916) pp. 43–5.

matter, and the eggs may be accidentally eaten by the millipede. For Muscid larvæ, probably of *Limosina*, are sometimes found on the gut of the millipede and are passed out living. In these cases there is more than phoresis.

Medical and Veterinary Entomology.*—W. B. Herms has written a systematic introduction to this subject, dealing with parasitic insects and Arachnids, disease-disseminators, poisonous forms, and the ways of coping with them.

Structure of Mesenteron of Insects.†—F. Supino refers especially to the intestine of the larva of *Oryctes* and related Lamellicorns. There are two layers of muscles, an external set of longitudinal fibres and an internal set of transverse fibres, the two sets being at right angles. The bundles of fibres appear to be embedded in a delicate amorphous elastic membrane. Most externally there is a connective layer ; second, there is the amorphous elastic membrane and the associated sets of muscle-fibres ; third, there is an amorphous basal membrane of a connective character ; fourth, there is the lining epithelium. The fundamental elastic membrane is interpreted as having to do with the dilatation of the mesenteron when filled with food.

Origin of Wings.‡—H. E. Crampton has subjected to critical examination the various theories as to the origin of wings. Tracheal gills and wings belong to different developmental series and are not homologous. The integumentary outgrowths on the sides of the tergum which are known as paranota are homodynamous with wings. It is probable that wings were derived from paranota.

Remarkable Ootheca from Nyasaland.§—James Waterston describes a peculiar ootheca from thorn-bushes. There appear to be no separate chambers, the eggs being merely embedded in layers in a matrix. The colour is light chocolate, more or less rufous ; the surface entirely rough and dull ; the whole hard. The eggs contained mature embryos, with strong mandibles pointing to phytophagous habits. The choice appears to lie between Hymenoptera and Coleoptera. Two parasites, an Acarid (*Pediculoides*) and a Chalcid (probably a new genus), were found within the ootheca preying on the ova.

δ. Arachnida.

Toxins of Spiders' Eggs.‖—Robert Lévy has made a thorough study of the toxins of spiders' eggs. In Epeiridæ there is a hæmolytic toxin (called arachnolysin by Sachs) in the female reproductive organs ;

* Medical and Veterinary Entomology. New York: (1915) 394 pp. (illustrated). See also Trans. Amer. Micr. Soc., xxxv. (1916) pp. 160–1.
† Rend. R. Ist. Lombardo, xlviii. (1915) pp. 316–21.
‡ Journ. New York Entomol. Soc. xxiv. (1916) pp. 1–39.
§ Journ. Zool. Research, i. (1916) pp. 91–6 (3 figs.).
‖ Ann. Sci. Natur. (Zool.) i. ser. 10 (1916) pp. 161–399.

it is got rid of completely or almost completely by egg-laying; it is absent in the young spider unless some of the yolk remains; it does not reappear till the gonads develop. It is a complex hæmolytic agent. It is present also in some Theridiidæ. In the eggs of *Tegenaria atrica* there is a different toxin, which is to be classified with the simple hæmolysins. In a number of spiders the eggs have no hæmolytic substance or "complement" thereof. Extracts of *Epeira* which include the ovary have a toxic effect. Besides causing general poisoning, a subcutaneous injection of arachnolysin has marked local effects, especially œdema and digestion of the tissues.

Some ova have a "complement" with hæmolytic action, e.g. *Meta segmentata* and *Tetragnatha montana*. The effect is toxic, but irregular. The "complements" are nearly related to arachnolysin. There are great specific differences. In *Tegenaria atrica* the eggs are hæmolytic and very toxic; in *T. parietina* they are non-hæmolytic and non-toxic. The poison of *T. atrica* differs from arachnolysin.

In spiders the poison of the cheliceræ is not hæmolytic. It has little action on Vertebrates, but a strong action on Arthropods (strikingly on the crayfish). There is no relation as yet known between the poison of the cheliceræ and that of the eggs. The blood of spiders has an anti-toxic action on the poison of the same species.

Notes on Parasitic Mites.*—Stanley Hirst deals with some species of Acari parasitic on mammals and birds in Great Britain, several being new to the British Fauna. He also describes two new African mites of the family Gamasidæ—*Hæmogamasus liberiensis* sp. n. from *Mus trivirgatus* and *Hæmolælaps* (?) *capensis* sp. n. from *Georychus hottentotus*.

ε. Crustacea.

Reproduction in Spiny Lobster.†—Bennet M. Allen, in the course of some notes on *Panulirus interruptus*, the spiny lobster of the Californian coast, refers to the very small coral-red eggs which are attached to the setæ of the pleopods. A careful estimate of the number of eggs carried by the 14-in. female showed it to be approximately half a million. Fertilization, or, as the author says, insemination (which does not seem strictly correct), "takes place from a putty-like mass of sperm material placed upon the ventral surface of the female's thorax between the last three pairs of appendages. This mass contains contorted tubular cavities in which the spermatozoa lie. It is at first white and soft, but in a short time turns black and becomes hard. It comes to resemble whalebone in consistency."

Gammarid Studies.‡—Charles Chilton describes *Orchestia miranda* sp. n., from New Zealand, differing from the common *O. chiliensis*, inasmuch as the largest males have the meral and carpal joints of the last

* Journ. Zool. Research, i. (1916) pp. 59–81 (14 figs.).
† Univ. California Publications (Zool.) xvi. (1916) pp. 139–52 (2 figs.).
‡ Trans. New Zealand Inst., xlviii. (1916) pp. 354–9 (6 figs.).

two peræopods widened into large flat plates. The author also discusses * some Australian and New Zealand Gammarids—*Melita festiva* (Chilton), *Mæra viridis* Haswell, *M. inæquipes* (A. Costa), *M. mastersii* (Haswell), and *Ceradocus rubromaculatus* (Stimpson)—most of which show considerable local variation. In a third paper † the author gives a detailed description of *Parapherusa crassipes* (Haswell); the systematic position, of the genus is probably, as Stebbing suggested, between the genera *Paramicruropus* and *Amathillopsis*.

Studies on Isopods.‡ — Walter E. Collinge describes *Pentias thompsoni* sp. n., an Idoteid from Yokohama. A description is also given § of *Idotea ochotensis* Brandt, and of an interesting abnormality ‖ —a fold in the sixth mesosomatic segment—in the normally straight gut of *Idotea linearis*. An account is given ¶ of the structure of *Mesidotea sibirica*, briefly described by Birula as *Glyptonotus sibiricus*, and it is shown ** that *Idotea elongata* should be referred to the genus *Crabyzoa*. Attention is directed †† to variations in some British woodlice.

Male of Cyathura carinata.‡‡—W. Omer Cooper found in Christchurch Harbour, Hants, large numbers of this Isopod, which has only twice previously been recorded from the British Isles. No description of the male has hitherto been published, and the gap is now filled. The first five abdominal segments are fused, at any rate dorsally, into a single segment without any trace of suture line. The flagellum of the antennules is rudimentary. The sexual stilet attached to the second pair of pleopods has a unique structure. It is "distinctly jointed at its base, terminating in a spoon-shaped expansion, from the base of which extends a large flattened lobe, standing out at an angle to the main stem of the organ, from the centre of which springs a slightly curved rod, furnished at its extremity with a crown of about eight large reflexed teeth."

In another paper,§§ J. and W. Omer Cooper record, from the same locality, *Heterotanais oerstedi* (Kroyer), which is remarkable in the relative large size and peculiar structure of the chelæ of the male. They also report *Paragnathia halidaii* (Bate and Westwood), the adult stages of which are almost terrestrial, living in small cavities in the banks, while the praniza-stages are parasitic on fishes.

Monograph on American Sessile Barnacles.‖‖—Henry A. Pilsbry is to be congratulated on the completion of a report on the rich collec-

* Trans. New Zealand Inst., xlviii. (1916) pp. 359–70 (6 figs.).
† Ann. Mag. Nat. Hist., xviii. (1916) pp. 199–207 (3 pls.).
‡ Journ. Zool. Research, i. (1916) pp. 33–5 (1 pl.).
§ Journ. Zool. Research, i. (1916) pp 82–5 (1 pl.).
‖ Journ. Zool. Research, i. (1916) pp. 86–8 (2 figs.).
¶ Journ. Zool. Research, i. (1916) pp. 112–8 (1 pl.).
** Journ. Zool. Research, i. (1916) pp. 119–20.
†† Journ. Zool. Research, i. (1916) pp. 121–4.
‡‡ Journ. Zool. Research, i. (1916) pp. 97–101 (4 figs.).
§§ Zoologist, xx. (1916) pp. 25–6.
‖‖ United States Nat. Museum, Bull. No. 93 (1916) xi and 366 pp. (76 pls.).

tion of sessile barnacles in the United States National Museum—a report which includes a splendidly illustrated monograph on the American forms.

Food of Pelagic Copepods.* — C. O. Esterly has made some experimental observations on the feeding habits and food of pelagic copepods, with reference to the question of nutrition by organic substances in solution in the water. Floating particles (grains of carmine in the experiment) are carried towards the mouth by water currents set up by the movements of the head appendages. The particles are definitely directed by means of the sides of a sort of trough formed by the long bristles of the anterior maxiliped. These appendages are stationary most of the time. A little pellet is formed, and is held immediately behind the mouth and taken in when the œsophagus is dilated. It is apparently not necessarily the ordinary movements of locomotion that cause the formation of the pellets, since animals may be kept for hours in water to which carmine has been added without injesting the particles, while in other cases the colour appears in the intestinal tract in a few seconds. Diatoms are the organisms, the remains of which appear most often, but in many cases the tracts are empty or contain only bits of débris and more or less of a green mass. The amount of food, as indicated by the intestinal contents, is surprisingly small in most cases, and does not bear out the figures given by Pütter. It is possible, however, that an important part of the food consists of plankton organisms without shells, which leave no recognisable remains.

Macrothrix hirsuticornis in the Trentino.† — Marco De-Marchi reports from Lake Fedaja the occurrence of this species of Daphnid, established by Norman and Brady. This is the first strictly Italian record, but the species has been collected in Alpine lakes by Imhof and Stingelin. It is a characteristic northern and Alpine species, but of very noteworthy adaptability to other situations. A full description is given.

Revision of Cheirurinæ.‡—Donald C. Burton has made a revision of this sub-family of Trilobites, and comes to the conclusion that the beginning of the Ordovician was a period of great variation of some primitive Cheirurid, and that the greater number of the genera are the result of contemporaneous and rather rapid differentiation at that time.

Annulata.

Spawn of Spio martinensis Mesn.§—F. Mesnil remarks on the few cases in which the spawn of marine Polychæts is securely known. That of *Phyllodoce maculata* is familiar; that of *Scoloplos mülleri* was

* Univ. California Publications (Zool.) xvi. (1916) pp. 171–84 (2 figs.).
† Rend. R. Ist. Lombardo, xlix. (1916) pp. 525–41.
‡ Washington Univ. Studies, iii. (1915) pp. 101–52 (25 figs.).
§ Bull. Soc. Zool. France, xli. (1916) pp. 32–5 (1 fig.).

for long referred to the lobworm (*Arenicola*), which has its eggs in a cord, in one row or in several rows. The spawn of *Spio* is a flattened tubular mass, 10–16 mm. in length, with a delicate envelope. The eggs are in one layer, or in several layers, each layer with about a dozen longitudinal rows. The colour is from yellowish-white to slightly orange. The eggs are briefly described.

Branchiura sowerbyi in France.*—R. Despax records the abundant occurrence of this interesting limicolous Oligochæt in the canal at Toulouse. The worm was found among the decomposing detritus at the margin, and the author regards it as probably indigenous. It lives with the anterior end embedded in the substratum, with the posterior branchiferous part floating out and ceaselessly undulating. Beddard described it in 1892 from *Victoria regia* tanks in the Botanical Society's garden in London, and Michaelsen from a similar situation in Hamburg. It has been generally regarded as an imported exotic. It should be noted, however, that L. Perrier recorded it from the overflow water-basins of the Rhône, and now we have its occurrence at Toulouse.

Genus Jasmineira.†—W. C. McIntosh discusses this genus instituted by Langerhans in 1880 for a minute Sabellid from Madeira. The differences which Langerhans indicated between *Jasmineira* and the other Sabellids, especially the Chonids, are by no means striking, but there is an essential feature which escaped him, viz. the remarkable elongation of the posterior hooks. In the British *Chone reayi* and the Canadian *C. princei* the typical Jasmineiroid hooks are present and carried a stage further, but in other respects these species link the genera *Jasmineira* and *Chone* closely together.

Spawning and Exuviation in Arenicola.‡—H. C. Williamson has made experiments with a view to obtaining normally spawned eggs of *Arenicola marina*. Some specimens from the Bay of Nigg were put into a box, with sand taken from the same place, on May 7th. A week later a greenish capsule containing green eggs was found, and four similar capsules appeared before the end of June. A larva examined between the fourth and sixth day showed two eye-spots. A zone round the larva had long, thick, tentacle-like cilia, turned towards the eyed end. The cilia worked for a little and then stopped, almost every second. Careful examination of the apparently gelatinous mass surrounding both the capsules deposited in the box and those found on the beach showed that it was in reality fibrous and was in all probability the cast-off skin of the worm, which is wrapped round the cocoon, and anchors it to a piece of seaweed or stone. From the fact that the capsules were found above the level of the sand—6 in. in one case—the author infers that the adult was swimming when the eggs were

* Bull. Soc. Zool. France, xli. (1916) pp. 46–8.
† Journ. Zool. Research, i. (1916) pp. 1–3.
‡ Journ. Zool. Research, i. (1916) pp. 102–11 (12 figs.).

deposited. No worm was ever observed above the surface of the sand during the day.

Snow-field and Glacier Oligochæta.*—Paul S. Welch describes from Mt. Rainer, Washington, *Mesenchytræus gelidus* sp. n., from elevations of 2700–5000 feet, and *M. solifugus rainierensis* var. n. from an elevation of 7500 feet. The description pays special attention to the minute structure of the reproductive organs. It is probable that the food consists in part of minute snow Algæ. The mature forms of both species are dark in colour, as are some other glacier animals. The pigmentation is probably in some way adaptive.

Nematohelminthes.

Sclerostome Parasites of Horse.†—Charles L. Boulenger describes *Triodontophorus tenuicollis* sp. n., *T. brevicauda* sp. n., *T. intermedius* Sweet, and *Œsophagodontus robustus* Giles, from English horses. Sclerostomes are responsible for a considerable amount of damage to horses, and it is very important that reliable and full information should be available in regard to the different forms and their life-histories.

Germ-cells in Ascaris incurva.‡—H. B. Goodrich has made a study of the development of the germ-cells in *Ascaris incurva*, a form which seems more suitable for investigation in the early stages than the better-known *A. megalocephala*. There is in *A. incurva* a sex-chromosome complex, consisting of eight x-chromosomes and one y-chromosome, which is mated by a definite component of the x-group. The elements of the x-group appear to be mutually independent except during the reduction division. The x-chromosomes are carried to one pole in the reduction division on account of their attachment to one member of a bivalent chromosome unit, consisting of the y-chromosome and its mate among the x-components; otherwise these elements are equally affected by the opposing forces acting during the first phase of mitotic division. The heterotypic mitosis may be divided into two phases; one characterized by action of equal and opposite forces from the spindle pole, the other by an apparent cessation of the forces and movements probably due to cytoplasmic currents. Measurement of volumes of nuclei of spermatozoa gives a bimodal curve, and the ratio between the volumes of nuclei of the modal classes is closely proportioned to the ratio between the numbers of chromosomes contributed respectively to the male-producing and female-producing spermatozoa. The x-chromatin is indistinguishable from other chromatin during the growth stages. The growth stages present a seriation comparable with that of other forms, and therefore *Ascaris* need not be considered

* Trans. Amer. Micr. Soc., xxxv. (1916) pp. 85–124 (4 pls.).
† Parasitology, viii. (1916) pp. 420–39 (1 pl. and 7 figs.).
‡ Journ. Exper. Zool., xxi. (1916) pp. 61–99 (3 pls. and 11 figs.).

exceptional among animals in regard to the interpretation of the nature of reproduction. Paired bodies resembling "pro-chromosomes" are found during the pre-synaptic stages, and these are transformed into parallel threads and enter the contraction figure, indicating a parasynapsis. A more intimate and orderly union of the paired threads in synapsis is observed in the oogenesis than in the spermatogenesis. Elimination of chromatin during cleavage occurs in the four-cell stage, as in *A. lumbricoides*, rather than at the two-celled stage, as in *A. megalocephala*. A copious bibliography is appended to the paper.

Trichostrongylus orientalis.*—K. Kitamura describes the peculiar ova of this Nematode which is widely distributed in Japan. It lives in man in the duodenum and in the beginning of the jejunum. The eggs occur in the fæces. They resemble those of *Ankylostoma* and *Necator*, but are considerably larger and show more numerous blastomeres. The development of the larvæ in free life may be divided into three stages—the first after the hatching out of the egg-shell, the second after the first moult, and the third after "encystation." At each stage the larvæ may be distinguished from those of *Ankylostoma* by the caudal characters, the arrangement of the intestinal cells, the length of the body, and so on. Infection may perhaps be effected cutaneously, as has been shown experimentally in the mouse. The worms are hardly of pathological importance. A full description is given of adults and larvæ.

New Acanthocephalan.†—H. J. Van Cleave gives a careful description of *Filicollis botulus* sp. n. from the intestine of an eider-duck. Till recently it would have been referred to the genus *Echinorhynchus*, but Lühe's attempt to solve the problem of the relationships of *E. polymorphus* Bremser, *E. anatis* Schrank, and *E. filicollis* Rudolphi, led him to establish two independent genera—*Filicollis* and *Polymorphus*. The proboscis of the female of the new species is atypical in being not inflated but like that of the male.

Platyhelminthes.

Tapeworms of Fowls and Sparrows.‡—F. J. Meggitt describes from fowls *Davainea dubius* sp. n., *D. cesticillus* Molin, and *Amœbotænia sphenoides* von Linstow. In regard to the last, the fatal effect of large numbers is noted. The Cestodes secrete a toxin which, when present in large quantities, acts as a strong poison, but which may have no apparent effect when diluted. The eggs may develop inside the brandling (*Allolobophora fœtida*), and a prick of a needle may liberate 10–30 cysticercoids from the intestine. From sparrows the author obtained *Choanotænia parina* Duj. and *Hymenolepis interruptus* Clerc.

* MT. med. Falkult. k. Univ. Kyushu, ii. (1916) pp. 1–59 (6 pls.).
† Trans. Amer. Micr. Soc., xxxv. (1916) pp. 125–30 (1 fig.).
‡ Parasitology, viii. (1916) pp. 390–410 (3 pls. and 1 fig.).

Triradiate Tapeworm from Horse.*—F. J. Meggitt describes a triradiate abnormality in *Anoplocephala perfoliata*, previously noted by Neumann. He shows how the disturbance of symmetry affects the excretory, nervous, and reproductive systems.

Leucochloridium macrostomum (Rud.) from Great Grey Shrike.†—J. Ritchie, jun., records this Trematode for the first time in Britain. He found it in the intestine of *Lanius excubitor*, and probably in the starling as well. The early stage is passed in the body of the snail *Succinea putris*.

Control of Head Form and Frequency in Planaria.‡—C. M. Child, continuing his studies on the dynamics of morphogenesis in experimental reproduction, has experimented on the control of head-form and head-frequency in planarians by means of potassium cyanide. The details of each experiment are given in tabular form. In general, he found that low concentrations of cyanide diminish head-frequency in pieces representing the anterior third of the first zooid, have little effect on the middle third, and increase frequency in the posterior third. Two factors are chiefly concerned in determining whether a head shall appear or not: 1. The reaction of the cells adjoining the cut surface; 2. The stimulation of the piece as a whole following section. The effects of cyanide are due to its action on these two factors. All the facts indicate that head-frequency varies directly with the metabolic rate of the cells concerned in head-formation, and inversely as the metabolic rate of other parts of the piece.

Rotatoria.

Male-production in Hydatina.§—A. F. Shull and S. Ladoff, starting from the established fact that certain agents reduce the number of male-producing females in *Hydatina senta*, have made investigations with the two-fold aim (1) of explaining how the agents prevent the appearance of the male-producing females; and (2) of discovering means of increasing male-producers. Their second line of research proved the more fruitful. They found that the effect of numerous substances in diminishing male-production is not due to osmotic pressure, acidity, or alkalinity, or to the mere retarding of certain processes. Very dilute solutions of calcium chloride repeatedly increased male-production in one parthenogenetic line and not in another. Magnesium chloride gave results that could not be interpreted, while potassium sulphate, iron chloride and ammonium chloride all reduced male-production, as did also dilute bouillon. Oxygen in the water increases male-production. Its effect is most marked in

* Parasitology, viii. (1416) pp. 379-89 (1 pl. and 2 figs.).
† Glasgow Naturalist, viii. (1916) pp. 42–5.
‡ Journ. Exper. Zool., xxi. (1916) pp. 101–26 (10 figs.).
§ Journ. Exper. Zool., xxi. (1916) pp. 127–61 (1 fig.).

counteracting the influences of other substances such as bouillon. The authors agree with Whitney in thinking that nutrition has some effect, but further experiment is needed to test the extent of its influence.

Echinoderma.

Effect of Radium Radiations on Rate of Cell-division in Arbacia.*—Charles Packard finds that the eggs of this sea-urchin, exposed to a brief but intense radiation during the period when the germ nuclei are approaching each other, are accelerated in their rate of cell-division. Less intense radiation produces less acceleration.

Exposures made during the prophase result in an acceleration unless they are prolonged, when a retardation ensues. During the metaphase the same phenomena appear, but to a greater degree. During the telophase the effects are much the same as in the prophase. Eggs exposed during the resting stage are not easily affected.

The power of the protoplasm and chromatin to absorb the radiations does not change during the periods of cell-division. The differences in the density of the chromatin during the different phases of mitosis do not affect its absorptive power. During the metaphase, when the eggs are most responsive to radiations, oxidations take place through the activity of enzymes. If these enzymes are accelerated or retarded, the effect is to accelerate or retard the rate of cell-division. Experiments indicate that radiations produce these effects on extracted enzymes. It may be inferred, therefore, that the endo-enzymes are affected in the same way, and that changes in the rate of cell-division, following radiation, are due to the direct action of the radiations on the rate of enzyme action.

Food of Sea-urchin.†—H. N. Milligan finds that *Echinus miliaris* eats dead or dying fishes, eggs of fishes, Ascidians, Cirripedes and small Crustaceans, dead Crustaceans of larger size, cast-shells of Crustaceans, fæces of crabs, dead and gaping Molluscs, eggs of dog-whelks, pieces of other Echinoderms, living members of the same purple-tipped species, living colonies of Polyzoa, tubes of Serpulids and the like, Hydrozoa, small sponges, Algæ of various kinds, sand and shell-gravel—an extraordinary range of food.

Cœlentera.

Firth of Forth Cœlentera.‡—Wm. Evans records *Haliclystus auricula* (Ratke); a species of *Rhizostoma*, probably *R. octopus* (L.); the little Medusoid *Phialidium cymbaloideum* (van Ben.), liberated from *Campanulina repens* or *C. turrita*; *Sarsia tubulosa*, *Melicertidium octocostatum*, *Eutonina socialis*, *Tima bairdii*, and the fine Ctenophore, *Bolina infundibulum*.

* Journ. Exper. Zool., xxi. (1916) pp. 199–211.
† Zoologist, xx. (1916) pp. 81–99.
‡ Scottish Naturalist, No. 59 (1916) pp. 283–6.

Sense-organs and Regeneration in Cassiopea.* — L. Cary has made a series of experiments to determine the influence of the marginal sense-organs on the rate of regeneration in *Cassiopea xamachana*. These Medusæ, with their nearly flat circular disks with sixteen equally spaced sense-organs, were found to withstand practically any operation, and to retain their vitality indefinitely in a medium-sized jar of sea-water. Experiments were made with entire disks from which all the sense-organs were removed, or with one half the organs removed, or with all but one removed, and so on. Full details of the experiments are given. The author concludes that his study of the influence of the sense-organs on general metabolism—as indicated by CO_2 production —shows that the metabolism of *Cassiopea* is influenced by the sense organs in a manner quite in accord with the differences in the rates of regeneration under the several sets of experimental conditions. The rate of regeneration is simply one expression of the general metabolic activity, and as such is subject, like many other activities, to the influence of the nerve centres.

Neuromuscular Arrangements in Sea-Anemones.† — G. N. Parker notes that the glandular, ciliary, and nematocyst systems are local in their reactions to environmental change, and remain normally responsive in animals anæsthetized with magnesium sulphate or chloretone. There is good reason to assume, therefore, that they are not under nervous influence. The muscular system, on the other hand, is so controlled. In *Metridium marginatum* there are at least thirteen muscles or groups of muscles. Two of these are ectodermic ; (1) the longitudinal muscle of the tentacles, and (2) the radial muscle of the oral disk. The remaining eleven muscles are endodermic : (3) the circular muscle of the tentacles, (4) of the oral disk, (5) of the œsophagus, (6) the sphincter, (7) the circular muscle of the column, (8) of the pedal disk ; the five mesenteric muscles :—(9) basilar, (10) longitudinal, (11) transverse, (12) parietal, and (13) the longitudinal muscles of the acontia.

The nervous mechanism is a network of neurofibrils and the like which permeates the deeper regions of the ectoderm and endoderm. Vigorous stimulation of almost any part of the surface is commonly and quickly followed by the complete contraction of the whole animal, and the response is very protracted.

The simplest type of muscular activity is seen in the longitudinal muscle of the acontium. It is brought into action by the direct application of an appropriate mechanical or chemical stimulus, and is without nervous connexions.

A second type is seen in the circular muscle of the column, which is open to direct stimulation, and is also under the control of nerves. In this respect it resembles the sphincter pupillæ of the vertebrate eye, which responds not only to nerve impulses but also directly to light.

A third type is seen in the longitudinal muscles of the mesenteries,

* Journ. Exper. Zool., xxi. (1916) pp. 1–32 (11 figs.).
† Proc. Amer. Phil. Soc., lv. (1916) pp. 340–3.

which fail to respond to stimulus when the animal is deeply anæsthetized. Hence it is concluded that their action is primarily controlled by nerves. Under ordinary stimulation their action is profound and lasting, and has given grounds to the idea that the actinian muscle is specialized almost exclusively on the side of its tonicity.

A fourth type is seen in the transverse muscles of the mesenteries, particularly of the complete mesenteries. When food-juice is discharged on the tentacles or lips the transverse mesenteric muscles contract and open the œsophagus, preparatory to what under normal circumstances would be the swallowing of the food. On withdrawing the stimulus these muscles quickly relax and the œsophagus closes. This reaction is so definite and precise in its relation to the stimulus, and so invariable in its occurrence, that it must be regarded as a true reflex.

The muscular reactions thus range from direct muscle responses of a most primitive character to true reflexes. The more complex operations of food-taking, creeping, and so forth, depend upon some combination of the various types of muscular or neuromuscular activity. These operations are often extremely complex, and call for a high degree of co-ordination; and yet this co-ordination is almost entirely of local origin, for an isolated tentacle will react to food almost exactly as an attached one does, and the pedal disk, even after the oral disk has been cut away, will creep in a fashion indistinguishable from that of an intact animal. It may be concluded that the nervous system of the sea-anemone is essentially diffuse, lacking obvious centralization.

Sagartia parasitica Mounting Shells.*—H. N. Milligan describes the way in which an isolated specimen of this sea-anemone, dropped into an aquarium, adhered to the *Nassa* shell of a passing hermit-crab, and gradually mounted it in about five minutes. It was removed from the Crustacean and tried with an empty whelk-shell, which it also mounted.

Porifera.

Gelatinous Spicules in a New Genus of Siliceous Sponges.†—Arthur Dendy describes *Collosclerophora arenacea* g. et sp. n., a tetraxonid sand-sponge with gelatinous microscleres (collosceres). The normal skeleton is almost entirely replaced by sand-grains. The megascleres are slender strongyla, occurring chiefly in loose wisps radiating towards the surface, where they form sparse surface-brushes. The collosceres (0·02–0·03 mm. in length) vary in form. When contracted they always show an indentation or notch on one side, and are sausage-shaped, boomerang-shaped, and kidney-shaped. They swell up and become gelatinous on the addition of water. They consist of colloidal silica, and are formed by special scleroblasts as extracellular secretions. They also occur in two other related sponges, as will be afterwards described. It is probable that in life the swollen colloslere fills the vesicle in which it lies. The wall of the vesicle may be regarded either

* Zoologist, xx. (1916) pp. 39–40.
† Proc. Roy. Soc., Series B, lxxxix (1916) pp. 315–22 (1 pl.).

as a concentration of the mesoglœa, due to the pressure of the collosclere, or as a precipitation membrane formed at the surface of contact, between the gelatinous collosclere on the one hand, and the gelatinous mesoglœa on the other, the former consisting of colloidal silica, and the latter presumably of an albuminoid character, both probably with small quantities of mineral salts.

Protozoa.

Heredity and Variation in Difflugia.*—H. S. Jennings has made an intimate study of heredity, variation, and the results of selection in the uniparental reproduction of *Difflugia corona*. This Rhizopod shows a number of very definite characters that are congenital, not modified by growth, and not affected by the environmental conditions during the life of the individual; these are therefore remarkably favourable for studies of inheritance. These characters are: (1) the number of the spines on the shell; (2) the length of the spines; (3) the diameter of the shell; (4) the depth of the shell; (5) the number of teeth surrounding the mouth; and (6) the diameter of the mouth.

In a population found in nature the individuals differ among themselves in all these characters. In large populations an increase in any one of the characters is accompanied on the average by an increase in the others. When a population is allowed to propagate, the characters of the parents are inherited in a high degree by the progeny. Co-efficients of correlation between parent and offspring rise even to 0·9 with respect to some of the characters.

Populations consist of many hereditarily diverse strains. The heritable characteristics of a given strain show a high degree of constancy through many generations, though the individuals within the strain may differ greatly in their personal characters. The strains show hereditary diversities with respect to the six characters enumerated above, and with respect to the way in which these are combined. A strain that shows one of the sets of hereditary characters in a higher degree may show another one in a low degree. The combinations distinctive of particular strains cannot be accounted for as due merely to the difference in some one underlying character, such as the size of the body.

When a single family is studied by itself (all descended by fission from one original parent), it is found that a considerable degree of correlation obtains between parent and offspring for most characters. In regard to some characters (e.g. the number of teeth, often also the diameter) the correlation of parent and offspring is very high (at times 0·5 or more). Sometimes this high correlation is due to a mere steady increase in size from generation to generation. But in most of the families the correlation is due to the inheritance of parental diversities.

Selection for diversities within the single family, e.g. as to number of teeth, was found to be effective. In regard to the size of the animal and the length of the spines, selection is much more rapid than in regard

* Genetics, i. (1916) pp. 407–534 (19 figs.).

to the number of the spines. After many generations of selection the family becomes much diversified with respect to the characters selected, so that the coefficient of correlation between parent and offspring may become almost as high as in populations.

In respect to the three characters referred to in the preceding paragraph, parents that deviate from the general mean produce progeny that deviate from the mean in the same direction as the parents, but to a less extent. Regression of the progeny towards (but not to) the general mean occurs.

The variations which are inherited in later generations are sometimes considerable in extent, so that they may be characterized as saltations (or mutations, if these be defined as marked inherited variations). But most of the inherited variations are very slight. After many generations of descent from a single progenitor a family will show differentiation into many hereditarily diverse stocks, differing hereditarily as to particular characters and also as to combinations of characters. In general, this interesting investigation shows that in *Difflugia corona* a population consists of many hereditarily diverse stocks; and that a single stock, derived by fission from a single progenitor, gradually differentiates into such hereditarily diverse stocks; so that by selection marked results are produced.

Feeding of Amœba.*—S. O. Mast and F. M. Root have made a series of observations on the feeding of Amœba with special reference to the surface-tension theory. The Amœba observed was a large lobose form corresponding, at least superficially, to the ordinary descriptions of *Amœba proteus*. They found that the Amœbæ feed at times almost exclusively on Rotifers, at other times largely on *Paramœcium*. They capture the Rotifers by flowing around the foot of the point of attachment to the substratum. The Rotifer responds by contracting and forcing the Amœba back, after which it extends again, and the Amœba begins to flow out over it. In the meantime the foot begins to digest, and gradually the Rotifer weakens. They continue thus sometimes for days before the Rotifer is swallowed. When the Amœba are feeding on *Paramœcium* they assume a sort of mushroom shape with a serrate edge consisting of numerous short pseudopodia. The Infusorians tend to come to rest between and under these pseudopodia by which they are usually surrounded, but sometimes the ends of the pseudopodia approach each other before they are fully extended, and cut the *Paramœcium* in two. To cut a *Paramœcium* in two with a fine glass fibre requires a pressure of approximately 9 mms. If the pseudopodia have the same cutting quality as the glass fibre, and if their movement is due to a change of surface-tension, it requires, to perform the work involved, a reduction in surface-tension of at least 1118 dynes per centimetre at the tips of the pseudopods. If the ends of the pseudopods fuse so as to take on the form of a ring round the *Paramœcium*, and if the cutting is due to constriction in this ring, and if the constriction is due to a change in surface-tension, the work involved requires a minimum reduction along the inner surface of the ring of 383 dynes per centimetre.

* Journ. Exper. Zool., xxi. (1916) pp. 31–50 (5 figs.).

The evidence seems to indicate that the *Paramœcium* is divided by the approach of the two pseudopods. On the basis of the surface-tension theory the surface-tension of the Amœba would require to be much higher than 383, and probably higher than 1118 dynes per centimetre. But the surface-tension of protoplasm is only about 50 dynes per centimetre, and it is probably at best an insignificant factor in the process of feeding in Amœba.

Ciliary Current in Free-swimming Paramœcium.*—S. O. Mast and K. S. Lashley note that when these Infusorians are at rest and are feeding, a cone-shaped current from a considerable distance in front of the animals proceeds down the oral groove towards the mouth, but that in the case of free-swimming individuals there are no appreciable movements of particles either in front of or along the sides of the animals. In free-swimming *Paramœcium*, *Stentor*, and *Spirostomum*, there is no continuous feeding-cone, as there seems to be in Rotifers. Water is sucked towards the free-swimming Infusorians through only a very short distance, probably a distance not over twice the length of the cilia. This distance is not great enough to make any warning of unfavourable environment ahead, which may be due to such currents, of any appreciable value.

The feeding-cone is produced by these organisms : (1) when they are at rest and are feeding ; (2) during locomotion, if they are retarded by lateral contact with resistant substances which are not uniformly distributed (e.g. bacterial masses, the substratum, etc.), or if the rate of locomotion is increasing or if it is decreasing (provided the decrease in rate is due to a reversal or a decrease in the activity of the cilia on the body without a similar change in the activity of those in the oral groove) ; and (3) in the avoiding reaction, but not until after the stimulus which causes such reactions has been received and the animals begin to turn. It is not the cause of the avoiding reaction.

Trypanophis grobbeni.†—J. F. M. Floyd gives an account of this Flagellate Infusorian, which, as Keysselitz records, is abundant throughout the gastro-vascular system of the Siphonophore, *Halistemma tergestinum*, where it can be detected even with a dissecting lens. None of the author's preparations showed a karyosome within the nucleus ("trophonucleus") nor a kinetonucleus at the base of the flagella. The free flagellum springs from a more or less distinct basal granule. The attached flagellum originates from the edge of the body at a point either on a level with the basal granule of the free flagellum or a little in advance of it. Along the whole length of the animal is a row of "chromatic bodies."

New Species of Opercularia.‡—N. M. Grier describes *Opercularia wallgreni* sp. n., found growing profusely on *Sagittaria*, in colonies of 2–200 zooids, which assume a nodding or pendant position after con-

* Journ. Exper. Zool., xxi. (1916) pp. 281–93 (6 figs.).
† Proc. Roy. Phys. Soc., xx. (1916) pp. 62–4 (1 pl.).
‡ Trans. Amer. Micr. Soc., xxxv. (1916) pp. 138–9 (1 pl.).

tracting. The food consists for the most part of unicellular Algæ, but Protozoa are also used. The ciliary disk has apparently but one circlet of cilia; the membranous collar is moderately large, but obliquely set; the stalk of the colony shows profuse dichotomous branching. The use of the term "polypidum" in reference to a colony of Protozoa is to be deprecated.

Fission in Hexamitus.*—Olive Swezy has studied the binary and multiple fission in species of *Hexamitus* from the rectum and large intestine of a number of Amphibians. In most cases *H. intestinalis* was the species met with. It may be noted that the genus is represented in rats, mice, snakes, tortoises, and fishes, as well as in Amphibians; and that *H. inflatus* occurs in stagnant water. The flagella are so minute that there has been prolonged uncertainty as to their number, which is eight, not six.

The cell-division is a simple form of mitosis, initiated by division of the blepharoplasts, followed by longitudinal splitting of both axostyles. Four chromosomes are found on the mitotic spindle, two going to each of the daughter-nuclei. New nuclear membranes are formed inside the old one, which fades and disappears before the completion of the process of cell-division.

Multiple fission takes place in the unencysted forms by a series of successive divisions of the two nuclei and the accompanying motor apparatus without corresponding division of the cell-body, forming a somatella of eight undivided binucleate individuals. These subsequently break up by successive splitting off of one individual at a time. The binuclear structure of the potential individuals is maintained throughout the process. Both binary and multiple fission occur similarly in at least two species, *H. ovatus* and *H. intestinalis*; multiple fission has been observed in a third species, *H. batrachorum*.

Monocercomonas and Polymastix.†—Olive Swezy has made a study of these two parasitic Flagellates from the food-canal of insect larvæ and Amphibians respectively. The generic characters of *Monocercomonas* are as follows: four equal anterior flagella arising from one or more blepharoplasts or basal granules; a large vesicular nucleus situated at the anterior end; a slender axostyle arising in the blepharoplast and terminating in the periplast at the posterior extremity of the body. The only authentic species are *M. melolonthæ* (Grassi) and *M. cetoniæ* Jollos.

The genus *Polymastix* differs from *Monocercomonas* mainly in the absence of an axostyle, the presence of striations on the definite periplast, and, in most cases, the extranuclear chromidial bodies or parabasal bodies. As *M. bufonis* Dobell possesses the generic characters of *Polymastix*, it should be called *P. bufonis* (Dobell).

The process of division in *P. bufonis* is a simple form of mitosis, exhibiting two chromosomes, pole-plates instead of centrosomes, and the formation of two nuclear membranes inside the old one, which disappears. The parabasal body divides by a simple constriction. The

* Univ. California Publications (Zool.) xvi. (1916) pp. 71–88 (3 pls.).
† Univ. California Publications (Zool.) xvi. (1916) pp. 127–38 (2 pls.).

division of the cytoplasm begins at the anterior end and proceeds posteriorly.

Kineto-nucleus of Flagellates.*—O. Swezy has made an experimental investigation of the "kineto-nucleus" of Hæmoflagellata and Hæmosporidia, with special reference to the binuclear theory of Hartmann. The kineto-nucleus is a structure correlated with endoparasitic life. It is not the kinetic centre of the cell, but a "kinetic reservoir," and it is suggested that the term "parabasal body," used by Janicki for similar organelles in the Trichonymphidæ, better indicates its relations in the cell. The author's results directly contradict those of Hartmann on the three main points put forward in support of his binuclear theory. She finds (1) that the "kineto-nucleus" is not composed of nuclear chromatin; (2) that it has not been found, in any single instance, to arise by division of the nucleus; and (3) in no instance could nuclear behaviour, as shown by mitosis, be claimed for it. The Hæmosporidia are not affiliated either morphologically or developmentally with the Hæmoflagellata, but are more nearly allied to the Coccidia. The order Bi-nucleata being founded on false premises, and composed of families totally unrelated, should not be retained as a valid order of the Mastigophora.

Temperature and Variation.†—Merkel H. Jacobs, in some notes on temperature and the activities of animals, suggests that high temperature may have been the cause of a heritable variation in *Paramœcium* observed in the Zoological Laboratory of the University of Pennsylvania. A three-vacuoled race appeared, which has remained constant for sixteen months. The author also refers to the severe conditions endured by the Rotifer *Philodina roseola*, which frequently passes in a few hours from what would be a tropical to what corresponds to an arctic environment.

Unusual Mode of Reproduction in Stylonichia.‡—R. D. Greenaway describes the liberation of a sort of bud from a somewhat mis-shapen and unhealthy specimen of *Stylonichia*. The excrescence bore uniform short cilia, and its cytoplasm was like that of the large individual. The isthmus connecting the two narrowed and elongated and broke; the whole process of liberating the bud or fragment taking about twenty minutes.

* Univ. California Publications (Zool.) xvi. (1916) pp. 185–240 (58 figs.).
† Proc. Acad. Nat. Sci. Philadelphia, lxviii. (1916) pp. 85–6.
‡ Zoologist, xx. (1916) pp. 198–9 (2 figs.).

BOTANY.

GENERAL,

Including the Anatomy and Physiology of Seed Plants.

Structure and Development.

Vegetative.

Abscission in Mirabilis.*—F. E. Lloyd has studied the phenomenon of abscission in *Mirabilis jalapa*, in order to prove that Hannig is incorrect in his view that in this species abscission is the result of the complete solution and destruction of a layer of tissue. The author finds that "there is no antecedent structural indication of the position of the abscission zone." In young parts one tier of cells gives evidence of physiological activity, while in older parts ten to twelve tiers are involved. The greatest activity is in the uppermost five layers, which constitute the separation-layer and correspond to Hannig's "Lösungsschicht." Abscission begins in the innermost part of the cortex, near the base of the internode, and extends inwards towards the pith and outwards to the epidermis; the uppermost tier of the cells involved changes most rapidly. The cell-walls undergo chemical change, and in the separation-layer the primary and secondary walls are completely digested; the tertiary walls separate from each other and from the partially altered primary and secondary walls of the next tier of cells. Only the uppermost tier of the separation-layer undergoes complete separation. Starch appears to be the source of energy in the process of separation. When separation is complete the protoplasts are left invested by a tertiary membrane which grows independently of other membranes. Neither cytoplasm nor nuclei take part in the degeneration changes, but they exhibit greater physiological activity, and are quite normal when separation is complete. There is no loss of turgor. The author concludes that Hannig is mistaken in regarding this as a new type of abscission, since the essential details are the same as those which occur in *Gossypium*, *Aristolochia*, etc.

Australian "Grey Mangrove."†—R. T. Baker contributes a paper dealing with *Avicennia officinalis*, popularly known as the "grey mangrove." After a brief discussion of the systematic position of this species, the author proceeds to a description of the leaves, breathing-roots, seed, timber, and bark. The leaves were found to exhibit two remarkable features: 1. Numerous depressions on the upper surface of the leaf, resembling stomata in appearance, but of different structure and function; these are probably contrivances for increasing the area of the

* Bot. Gaz., lxi. (1916) pp. 213–30 (1 pl. and 2 figs.).
† Journ. and Proc. Roy. Soc. New South Wales, xlix. (1916) pp. 257–81 (19 pls.).

epidermal cuticle. 2. The peculiar orientation of the leaves, which appears to serve the purpose of providing the shade necessary for the breathing-roots. The histological examination of the stem shows that there are no true medullary rays, since each ray is restricted in length to the width of each ring; bands of vertical walls of sclerenchymatous cells limit the length of the rays. The phlœm-cells, which form regular clusters on the outer edge of each ring, appear to be capable of functioning as ordinary bark. The wood-fibres have a somewhat remarkable distribution, and the wood-parenchyma between them and the stone-cells apparently performs the work of cambium. There is nothing corresponding to the spring and autumn growths found in other dicotyledonous trees, although the annual rings are well-defined; the greatest peculiarity of the rings is their discontinuity, the break being due to the intrusion of another "ring" in juxta-position but at quite a different angle to the normal ring. The author has given especial attention to these rings, and finds no evidence to support the theory that they are due to forest fires or difference in tides. In his opinion they are due to an endeavour to attain a maximum of strength by a minimum of weight, disposed in fibres or breaks as required by the large amount of foliage borne by the tree; they may also give strength to resist river-currents and tides. A noticeable feature of the tree is the impossibility of killing it by ring-barking. This appears to be due to each "ring" being in itself a fascicular bundle, so that destruction of the bark only deprives the tree of a ring of outer cortex, and the numerous remaining phlœm-streaks are able to carry on the function of the injured outer portions.

Reproductive.

Floral Pedicel of Mesembryanthemum.*—G. Barthelat contributes a short note upon the structure of the floral pedicel of *Mesembryanthemum*. The author finds that at least twenty-five species of this genus have fibro-vascular bundles in the cortical tissues of the pedicels. These bundles vary in number and extend to different levels of the floral axis. In some species they form a more or less regular circle in the central parenchyma, and terminate in the lower half of the pedicel without forming any connexion with the chief bundles of the central cylinder; their orientation is normal. In other species the structure and disposition are analogous, but the bundles extend into the upper portion of the floral axis. All these bundles have the same origin; they are secondary, descending bundles which arise in the sepals, and, after crossing and anastomosing in the ovary, pass into the pedicel. The number, disposition, and importance of the principal bundles of the central cylinder are in close connexion with the structure of the flower.

Parthenogenesis, Parthenocarpy, and Phenospermy in Nicotiana.† T. H. Goodspeed has investigated the claim of Mrs. Thomas to have

* Comptes Rendus, clxiii. (1916) pp. 366–8.
† Univ. California Publications (Bot.) v. (1915) pp. 249–72 (1 pl.).

produced parthenogenetic seed without difficulty in species and hybrids of *Nicotiana*. The species used for the experiments was a white-flowered variety of *N. Tabacum*, this being the variety with which Mrs. Thomas was most successful. Previous investigations dealing with over 1000 attempts to produce parthenogenetic seed from numerous other species, varieties, and hybrids of *Nicotiana* gave entirely negative results. The most successful results were those obtained with the above-mentioned variety, where 800 castrations and mutilations of buds produced over 100 normal fruits; but the majority of these parthenocarpic fruits produced merely a large number of empty seeds and a few flattened or shrivelled seeds. The production of such seed may be regarded as a process of phenospermy. About fifty seeds from nine parthenocarpic fruits were, however, found to contain normal endosperm and embryos; eighteen such seeds produced six seedlings, which have attained a fair size. A small portion of the seed was neither parthenogenetic nor phenospermic, but contained traces of nothing but endosperm. The author is thus able to confirm Mrs. Thomas's results so far as this species is concerned, but his experiments appear to show that parthenogenesis is limited in *Nicotiana* to this one strain, known as *N. Tabacum Cuba*.

Anomalies in Linaria.*—P. Vuillemin contributes a note upon the anomalous flowers of *Linaria*. Forty-nine such flowers were examined, and were found to be anomalous in the number and form of the spurs and in the number of petals and stamens; in the majority the numbers of spurs, petals, and stamens were in excess of those characteristic of the normal flower. This may be the result either of partition or reduction of the parts of the original normal flower. There is no evidence in favour of partition, but rudimentary vestiges of petals in several abnormal flowers favour the view of reduction; thus the origin of these abnormalities appears to be a typical decamerous flower. But the normal *Linaria* flower is of a fixed pentamerous type, so that a decamerous flower can only exist by a union of the buds of two pentamerous flowers. Thus gamogemmy must be regarded as the cause of these anomalies. Such gamogemmy has been shown by the author to be the result of injury of the axis of the inflorescence.

CRYPTOGAMS.

Pteridophyta.

(By A. Gepp, M.A., F.L.S.)

Hippochæte in North America.†—O. A. Farwell, after studying the genus *Equisetum* of the United States, is convinced that the species should be grouped under two genera: 1. *Equisetum*, with stems annual, often dimorphous, the sterile always with regular verticils of acutely angled branches at the nodes; spikes rounded at apex;

* Comptes Rendus, clxiii. (1916) pp. 382–5.
† Mem. New York Bot. Garden, vi. (1916) pp. 461–72.

stomata scattered (type species, *E. arvense*). 2. *Hippochæte*, with stems generally evergreen, not dimorphous, usually simple; branches, when present, similar to the stem; spikes usually apiculate; stomata in regular rows (type species, *H. hyemalis*). The genus *Hippochæte* was proposed by Milde in 1865. Further, Farwell would split this genus into two sections—*Euhippochæte* (stems evergreen, spikes apiculate) and *Ambigua* (stems annual, spikes obtuse or apiculate, ridges rounded). And he provides a key in which the characters that separate the species are to be found in the ridges and sheaths, whether concave and biangulate, or convex and banded, campanulate or cylindrical. He describes also two very distinct types of anatomy in *Hippochæte*—the one with the vallecular bast abundant, the other with the carinal bast abundant.

Vittaria and Antrophyum.*—G. Hieronymus, having revised the Vittarieæ of the Berlin Herbarium, found it necessary to separate off several new species of *Vittaria* and *Antrophyum*, and publishes detailed descriptions of them. A further series of new species from New Guinea and tropical Africa are destined for Engler's "Botanisches Jahrbuch."

Bryophyta.

(By A. Gepp.)

Resting Moss-protonema.†—B. M. Bristol describes and figures some remarkable examples of moss-protonema which, after lying dormant for nearly half a century in samples of soil stored in sealed bottles at the Rothamsted Experimental Station, germinated when placed under cultivation. When carefully cleaned from particles of soil, the new green protonema was found to have arisen from distorted resting-cells with enormously thickened walls, and containing greenish-yellow oil-drops. These oil-drops disappear as the new shoots develop and produce their chloroplasts. No such resting moss-protonema appears to have been observed hitherto.

Ecology of Mosses.‡—B. Kessler gives an account of his experiments in connexion with the ecology of mosses. He finds that the germination of moss-spores is influenced by the reaction of solutions. The same reaction works differently on the spores of species from different habitats. The behaviour of spores in a solution of acid or alkaline reaction shows a relation to the habitat of the moss-species. The spores of chalk-loving species (*Hypnum molluscum*, *H. commutatum*, *Barbula muralis*, *Bryum cæspititium*, *Orthotrichum saxatile*, *Grimmia pulvinata*, *Plagiopus Œderi*) demand an alkaline reaction. Mosses of damp humus and swamp-land (species of *Sphagnum* and *Polytrichum*, *Pogonatum*, *Tetraphis*, *Dicranella heteromalla*) demand an acid reaction. The spores of the so-called widely distributed species and of those which prefer

* Hedwigia, lvii. (1916) pp. 200–14. See also Bot. Centralbl., cxxxii. (1916) p. 442.
† New Phytologist, xv. (1916) pp. 137–43 (figs.).
‡ Beih. Bot. Centralbl., xxxi. 1te Abt. (1914) pp. 358–87 (1 fig.).

a soil free from lime (such as *Hylocomium loreum*, *Hypnum Schreberi*, *H. cupressiforme*, *Mnium punctatum*, *Barbula subulata*, *Bartramia pomiformis*, *Bryum argenteum*, *Dicranum scoparium* and *Hedwigia ciliata*) germinate in a neutral to weak alkaline solution. In nature, this influence of the reaction on germination determines the distribution of the species. Bogs and damp humus have an acid reaction; other soils have an alkaline reaction, strongly alkaline in case of the lime-containing rocks. The calcareous contents of the rock do not act as such, but through the presence of OH-ions. The spores of mosses which grow on dry rocks sink to the bottom in water, while those of other mosses float. The species with spores that sink are more adapted for habitation on dry rocks; when the rocks are wet they remain in the rock crevices, whereas floating spores would be washed off. The possibility of distribution is greater for the spores of species growing in dry places, on account of the greater movement of air prevailing there. The absence of these species in damp habitats is probably caused by the much quicker germination of the mosses that are suited for damp places. The time of ripening of the sporogonium of mosses growing in dry places takes place during the period between the maximum of dampness of soil and that of the maximum of summer rainfall—that is, in spring-time. With increasing dampness of habitat, the time of ripening is more evenly distributed over the different seasons. An attempt was made to increase the speed of the germination of the mosses from dry, sunny habitats by previous warming, but without marked success. A connexion was not firmly proved between a capability of germinating in the dark in an inorganic solution and a particular habitat, but it possibly exists. Germination in the dark succeeds more easily in a lesser concentration of inorganic nutritive solution. It was impossible to germinate certain species in the dark. Excretions of lime on the leaf-points of mature plants were only noticed on calcifuge species.

Moss-calyptra with Stomata.*—P. Janzen describes the occurrence of stomata on quite normally formed calyptra of *Encalypta ciliata*. Stomata are common on the thallus of frondose hepatics, on the receptacles of Marchantieæ, and on the sporogonium of *Anthoceros*; but are unknown on the foliose hepatics. On the capsules of mosses they are frequent. The stomata of the calyptra of *Encalypta ciliata* are described as being structures arrested in development. The author recommends that the calyptras of *Funaria*, *Campylopus*, *Trematodon*, *Grimmia*, etc., which, like *Encalypta*, are provided with water-sacks, should be examined for similar stomata.

Fossombronia crispula in Indiana.†—E. J. Hill gives an account of *Fossombronia crispula* Austin, with a description of its structure, and of the nature of the habitats in which he has found it in the Dune region of Indiana. It occurs in sloughs from which the water has dried away, especially on the vertical sides of old footmarks left by cows in the drying mud in summer-time. The plant is evidently annual, the

* Hedwigia, lvii. (1916) pp. 263–5. See also Bot. Centralbl., cxxxii. (1916) p. 409.
† Bryologist, xix. (1916) pp. 67–8.

spores lying dormant during the rainy season. An important character of this species is the form of the elaters, which are very small, short, cylindric, straight, or occasionally slightly curved, with very obtuse ends and a single feeble spiral.

Fissidens.*—J. A. Wheldon describes *Fissidens pusillus* var. *Wilsoni*, a new variety, and indicates the points of structure in which it differs from other varieties of *F. pusillus* and from *F. incurvus* and *F. viridulus*. He discusses the systematic value of the inflorescence of mosses, and, in view of its variability, he is inclined to regard with suspicion the status of species which are founded mainly upon the position of their inflorescence. As to the morphological meaning of the anomalous leaf of *Fissidens*, he is in agreement with the interpretation which E. S. Salmon put forward in 1899 upon evidence furnished by the structure of the vascular tissue of the costa.

Psilopilum cavifolium.†—I. Hagen shows *Polytrichum cavifolium* Wils., an Alaskan moss in Seemann's Botany of H.M.S. 'Herald' (1852), to be identical with *Catharinea tschuctschica* C. Müll. (1883) in the entire margin of its leaves, the narrow nerve bearing few lamellæ, and the almost apiculate tips of the leaves. The plant must be called *Psilopilum cavifolium*.

Exotic Mosses.‡—G. Roth, in a supplement to his "Aussereuropäischen Laubmoose," gives diagnoses in German of the seven species of *Andreæa* described by Brotherus, published with Latin diagnoses in "Bibliotheca Botanica," Heft 87. They were collected by Th. Herzog in the Bolivian Andes. Three other species previously published are here described. Figures of the structure of each species described are given.

Dalmatian Liverworts.§—V. Schiffner publishes the results of his study of the Hepaticæ of Dalmatia, founded on J. Baumgartner's collections in all parts of that region. He records only eighty-seven species, due to the scarcity of water and woodland and the nature of the soil, which is not favourable for Hepaticæ. He discusses ecological problems, and then gives a systematic list of species, with critical notes on structure, etc.

V. Schiffner‖ also discusses the Hepaticæ collected by A. Latzel in South Dalmatia and the neighbouring parts of Herzegovina, particularly near Ragusa, Mount Orjen (1895 m.). The new species are *Riccia Latzelii*, related to *R. Bischoffii*, but differing in habit; and *Cephaloziella Latzeliana*, with perianth-mouth deeply cleft into several lobes with

* Journ. Bot., liv. (1916) pp. 317–22.
† Bryologist, xix. (1916) p. 70.
‡ Hedwigia, lvii. (1916) pp. 257–62 (1 pl.). See also Bot. Centralbl., cxxxii. (1916) p. 442.
§ Oesterr. Bot. Zeitschr., lxvi. (1916) pp. 1–21 (figs. in text). See also Bot. Centralbl., cxxxii. (1916) p. 352.
‖ Verh. k.k. Zool. Bot. Gesell., lxvi. (Wien, 1916) pp. 186–201 (figs.). See also Bot. Centralbl., cxxxii. (1916) p. 353.

short cilia-like teeth. It is most closely allied to *C. Jackii*, and grows in thick tufts of *Dicranum scoparium*. New forms are described, and twelve species are recorded as new to Dalmatia.

New Mosses from East Asia and South America.*—T. Herzog publishes new genera and species of mosses from Ceram and Buru, from Malacca and New Guinea, from the low-lying country of La Plata and Eastern Bolivia, and from the High Cordilleras in the province of Mendoza. The mosses were collected by various people. The new genus *Hymenodontopsis* resembles *Hymenodon* in habit and peristome, but differs in having smooth cells, globular capsules, and a remarkably long beak to the calyptra. *Pseudothuidium* differs from *Thuidium* chiefly in its lack of paraphyllia and the shape of the cells, which are elliptic to lanceolate-elliptic. *Cribrodontium* is allied to *Entodon*, but differs in the sieve-like perforations in the thickened lamina of the teeth, and also in the apical splitting of the teeth.

Bryophyta of Bolivia.†—T. Herzog publishes a full account of his second journey to Bolivia in the autumn of 1910. His object was to explore thoroughly the Eastern Cordilleras between Santa Cruz and the high plateau of Titikaka, a region hitherto but poorly known botanically. It includes tropical primeval forest and pampas, and rises to the region of the eternal snow, so that the material collected was plentiful and varied. The species of mosses number 706, the liverworts 444—a total of 1150 Bryophytes in all. After a geographical introduction describing the tour follows the systematic portion. The five Sphagna are determined by J. Röll, the Andreæales by V. F. Brotherus. New species are described. The Eubryales are worked out almost entirely by the author himself. He describes eight new genera and many new species. As an instance of the necessity of enlarging our views on morphology and phylogeny, an example may be quoted of a new species, *Catharinæa elamellosa*, which was found in fruit; the lamellæ on the upper leaf surface, which were considered obligatory for the genus, are entirely wanting. Multicellular spores are recorded for two new species, *Cryphæa gracillima* and *C. macrospora*. *Bartramia* and *Breutelia* are richly represented in the region. The new species are well figured, both in the text and on plates.

The Hepaticæ are worked out by F. Stephani, who describes as new 53 p.c. of the species. In the genus *Plagiochila* 87 of the 137 species recorded are regarded as new. Numerous figures drawn in outline show the differences in structure of the newly described species.

In the geographical part of the work the author gives a review of the most important families of the Andine moss-flora of Bolivia, of which Prionodontaceæ is the chief. He also describes the whole explored region with its different sections and the species inhabiting them. Under "moss-formations" he treats of the biology and physiog-

* Hedwigia, lvii. (1916) pp. 233–50. See also Bot. Centralbl., cxxxii. (1916) p. 441.

† Bibliotheca Botanica, lxxxvii. (1916) pp. 1–347 (1 map, 8 pls., and 234 figs. in text). See also Bot. Centralbl., cxxxii. (1916) pp. 439–41.

nomy. Following the lead of Giesenhagen he develops here an enlarged system of growth-forms of mosses. He also publishes a map of the Bolivian Eastern Cordillera, constructed according to the results of his own careful explorations, and constituting the first trustworthy map of the district. The whole work is one of the utmost importance to bryologists.

Australian Sphagnaceæ.*—K. Kavina writes on the Sphagnaceæ of Australia. He finds that of the twenty-four species occurring in Eastern Australia only five are cosmopolitan. All the others are endemic. Of the Acutifolium and Squarrosum groups no representative has been found up to the present. A new species is described, intermediate between *Sphagnum Brotherusii* Warnst. and *S. Scortechinii* C. M.; and *S. vitianum*, hitherto only recorded from the Fiji Islands, was found.

Japanese Bryophyta.†—S. Okamura publishes a second contribution to the moss-flora of Japan, and gives detailed descriptions of thirty-one new species of mosses and three new varieties, also nine rare species which are but little known, and a new hepatic; and he gives figures of their morphology and structure, and systematic keys to some of the genera. The plants were collected in Hondo and Formosa for the most part, and a few in Korea.

Guide to Mosses.‡—Elizabeth Marie Dunham publishes "A Popular Guide to the Mosses of the North-Eastern United States," containing keys to 80 genera, and short descriptions of over 150 species, with special reference to the distinguishing characteristics that are apparent without the aid of a lens. For the genera there is a key to the leaves, and a key to the capsules. The book is illustrated, and it has the merit of calling attention to the mode of occurrence, substratum and general habitat of the moss-genera; but naturally it omits the minute mosses.

Thallophyta.

Algæ.

(By Mrs. E. S. Gepp.)

Fresh-water Algæ.§—F. E. Fritsch and F. Rich continue their studies on the occurrence and reproduction of British fresh-water algæ in Nature. The present contribution gives the result of a four-years' observation of Barton's Pond, near Harpenden. In the introduction the authors discuss the physical features of the pond, the meteorological data, the flora of the pond, and the annual cycle in the flora. At the

* Sitz.-ber. k. Böhm. Ges. Wiss. Math.-Nat., Kl. ix. (1916) pp. 1–8 (fig.) See also Bot. Centralbl., cxxxii. (1916) p. 351.

† Journ. Coll. Sci. Imper. Univ. Tokyo, xxxviii. Art. 4 (1916) 100 pp. (42 figs.).

‡ Boston (Mass.): Houghton Mifflin Company (1916) 287 pp. (figs.). See also Bryologist, xix. (1916) pp. 74–5.

§ Ann. Biol. Lacustre, vi. (1913) pp. 33–115 (3 Charts and 1 fig.). See also Bot. Centralbl., cxxxii. (1916) pp. 324–7.

end of the paper the results are summarized. The algal flora of Barton's Pond is dominated by a successive association (formation ?) of *Microspora*, *Eunotia arcus*, *Conferva*, *Zygnemaceæ*, *Oedogonium*, *Protococcales*, *Euglena*, *Anabæna*, species of *Trachelomonas* and epiphytic Diatoms. The flora is very rich and shows a very pronounced periodicity, related somewhat to that of the phanerogamic flora. Four main phases are distinguishable in the annual cycle: 1. Winter phase, with an abundance of *Microspora* and Diatoms. 2. Spring phase, with dominant *Zygnemaceæ* and *Oedogonium*, and numerous *Protococcales* as subsidiary forms. 3. Summer phase, with dominant *Euglena* and *Anabæna*, *Ineffigiata* and Desmids being important subsidiary forms. 4. Autumn phase, chiefly characterized by renewed development of many of the filamentous forms and by the presence of species of *Trachelomonas* and *Oscillarieæ*. A profound relation between the frequency of the algal flora and the meteorological conditions has been established. The relation between sunshine and the sexual reproductive process is very plain, confirming Klebs's conclusions.

Dicranochæte reniformis.*—W. J. Hodgetts gives a detailed account of the minute anatomy, reproduction and life-history of *Dicranochæte reniformis*, a small green alga which was originally discovered in Silesia, was described by Hieronymus in 1887 and 1890, and has recently been found near Birmingham—the first record for this country. Owing to its long branched setæ *Dicranochæte* holds a somewhat isolated systematic position. The only other species that has been recorded is *D. britannica* G. S. West, which was gathered in mountain pools of North Wales in 1912.

New Penetrating Alga.†—Elizabeth Acton gives a description of *Gomontia Ægagropilæ*, a new green alga found growing in the walls of dead cells of *Cladophora* (*Ægagropila*) *holsatica*, collected in Loch Kildona, Hebrides, and cultivated for some years in a pie-dish. The *Gomontia* had also penetrated and spread beneath the glazed surface of this pie-dish at numerous spots. The author describes and figures the structure and ramification of the alga, and its means of multiplication. She also discusses its systematic position, and reviews the three genera of boring algæ—*Gomontia*, *Tellamia* and *Foreliella*. *Tellamia* she transfers to *Endoderma*; and *Foreliella* she unites with *Gomontia*.

Tetracyclus.‡—F. Hustedt publishes some critical studies on the structure and systematic position of the genus *Tetracyclus*. The points of systematic value are the form of the frustule, the girdle and the septa. The species having the greatest power of variation is *T. ellipticus* Grun. The various differences are indicated, with the resulting forms. Diagnoses are given of eleven species. Two others are uncertain, and

* New Phytologist, xv. (1916) pp. 108–116 (1 fig.).
† New Phytologist, xv. (1916) pp. 97–102 (1 pl. and figs.).
‡ Abh. Natur. Ver. Bremen, xxiii. (1914) pp. 90–107 (1 pl. and fig. in text). See also Bot. Centralbl., cxxxii. (1916) p. 431.

five are nomina nuda. A list of synonyms is given and a key to the species. The many new forms of *T. ellipticus* are represented on a plate.

Diatoms from the Province of Posen.*—V. Torka publishes a list of 105 Diatoms collected in the streams of Brahe and Netze. Some are new records for the Province. In the Netze are found a considerable number of halophil species, due to the fact that several tributaries coming from the salt lands of Pinsk and Salzdorf empty themselves into it.

Structure of the Nucleus in Algæ and its Systematic Signification.†—H. v. Neuenstein writes a dissertation in which he reviews all literature dealing with nuclear structure in algæ except Cyanophyceæ, and adds thereto a series of original observations made on numerous algal nuclei, particularly *Microspora amœna.* His object was to determine whether the arrangement and composition of the nuclear elements, and especially the behaviour of the nucleus during division, served as a trustworthy guide towards relationship. The systematic position of doubtful genera could then be determined. His results were as follows. On the whole the nuclear conditions are similar in related groups. At first sight it would seem as if there were no connexion between nuclei and systematic grouping, for all sorts of nuclei are represented, from karyosome nuclei to those which differ in no way from those of the higher plants. The few forms having karyosome nuclei must be regarded, however, as exceptions—*Spirogyra*, *Sphæroplea* and the Nemalionales. The often-occurring centrosomes, particularly in the Diatoms, recall animal objects. The number of the nuclei in each cell is not so systematically important as the structure. The rule is to be uninucleate. Exceptions are found in Confervales, where most of the genera are uninucleate, while *Ophiocytum* and *Botrydium* are multinucleate. For that reason *Botrydium* has lately been placed in Siphonales. In Florideæ uni-multinucleate plants of the same species occur, the number of the nuclei increasing with the size of the cell. However, the inclination to multiply nuclei with age is confined to distinct groups. The author gives the special characteristics of the separate families, which, however, are too long to reproduce here. The results of the investigation show that cytology confirms the present system of the algæ. No new relationships have been established. But it is proved that nuclear structure and the behaviour of the nucleus during division and fertilization are not only advisable but necessary for systematic purposes.

Sapropelic Algæ.‡—R. Lauterborn writes on the biology of the foul mud found in natural waters, such as ponds or water-holes in woods,

* Zeitschr. Deutsch. Ges. Kunst. u. Wiss. Posen, xxii. (1915) pp. 26–36 (3figs.). See also Bot. Centralbl., cxxxii. (1916) p. 409.

† Dissert. Heidelberg, 1914, 91 pp. (20 figs.). See also Bot. Centralbl., cxxxii. (1916) pp. 432–3.

‡ Ver. Nat. Med. Vereins Heidelberg, n.f. xiii. (1915) pp. 395–481 (pls.). See also Bot. Centralbl., cxxxii. (1916) pp. 401–3.

old ditches, and particularly water where masses of Characeæ grow. The principal time of vegetation is in late autumn and before spring begins; in other words, at the period when the great decay of vegetation takes place. Either fresh- or sea-water, and especially sulphur springs, are favourable for the production of sapropelic organisms. Apart from the bacteria and animal organisms recorded, the author mentions as characteric certain species of *Oscillatoria* and *Lyngbya*, *Spirulina flavovirens* Wisl. and *Pseudanabæna constricta* Lauterb. and *P. catenata*. Diatoms and Chlorophyceæ are to a certain extent negatively characteristic. A notable point are the pseudovacuoles of many sapropelic Cyanophyceæ, called by Molisch airosomes. They probably contain, stored up, a product of metabolism, which is physically very labile, and can be drawn on as a source of energy. The principal part of this paper is zoological.

Algæ of North Croatia.*—J. Pevalek publishes the results of his three-years' exploration of North Croatia for algæ. He records 200 species, of which two are new. The ecology is fully discussed. The most interesting point of the paper relates to the periodicity of the species of *Spirogyra*. In the early spring only quite thin species with a single chlorophyll band occur, *S. Weberi*, *S. varians*, *S. porticalis*. In summer thicker species occur, which are more intensely coloured, with several chlorophyll bands, and with not folded partition walls. In autumn the species are once more thin and pale. The author attributes this periodicity to the change in the light intensity, comparing the chlorophyll bands to the palisade cells of leaves. Further, the author confirms Molisch's observation on the phycoerythrin of *Porphyridium cruentum*. *Notommata* galls on *Vaucheria* were studied. and the active penetration of the parasite into the algal filaments was observed.

Algæ of Wisconsin Lakes.†—G. M. Smith describes new species of algæ collected from the lakes of Wisconsin, and adds notes on other species. Camera lucida drawings illustrating the structure of all the plants are given. Eleven new species and four varieties are defined, also a new genus, *Glœocystopsis*, which combines the general morphological characteristics of *Glœocystis* Naeg. and the cell shape of *Nephrocytium* Naeg. The mucilaginous cell-wall is not laminated; the cell is curved sausage-shaped, not ovoid. The reproduction requires further study.

Codium mucronatum.‡—Annie M. Hurd has made a study of *Codium mucronatum* based on material from Puget Sound. Her object is to determine the validity of the varieties *californicum* and *novæ-zelandiæ* J. Ag., and to establish specific characters sufficient to distinguish the species. She draws up a detailed diagnosis and decides that the varieties based on variation in the mucronate tip are not justified, since all variations are often found on the same plant.

* Bull. Trav. Ac. Sc. Slaves du Sud Zagreb. Cl. Sc. Math.-Nat., Sv. v. (1916) pp. 121–32. See also Bot. Centralbl., cxxxii. (1916) pp. 433–4.
† Bull. Torrey Bot. Club, xliii. (1916) pp. 471–83 (3 pls.).
‡ Puget Sound Marine Stat., Publ. i. (1916) pp. 109–35 (6 pls.). See also Bot. Gaz., lxii. (1916) p. 336.

Remarkable Symbiotic Algæ.* — J. Schiller describes a new departure among algæ in the form of a Siphonaceous species which is entirely devoid of chlorophyll, has a cell-membrane which contains chitin, and lives in symbiosis with *Nostoc symbioticum*, a new species. It was found by F. von Wettstein in a cabbage-field in Upper Austria, and called by him *Geosiphon pyriforme*. It forms an analogy to the lichens, and may lead to an understanding of the connexion between the formation of chitin and organic nutrition.

Development of Griffithsia corallina.†—H. Kylin describes in detail the structure of the shoot of *Griffithsia*, the division of vegetative cells and nuclei, development of the procarp till it is ripe for fertilization, and after fertilization, development of cystocarps, spermatia and tetraspores. The somatic nuclear divisions follow the same course as in *Rhodomela virgata*. The female branch bears in *G. corallina* two procarpia, in *G. Bornetiana* one. The carpogone of Florideæ appears often to have two nuclei. Of the procarpia, often only one develops into a gonimoblast. The carpospores are always uninucleate. After fertilization the guard-cells begin to develop; they are formed from the first central cell (the basal-cell) of the female branch, and consist of two cells. The upper one is the guard-cell proper, the lower one represents a connecting cell between the guard-cell and the basal cell of the branch. The spermatangia are formed on very much branched tufts, which grow in a crowded mass between two cells of the main branch. The lower cells of the main branchlets are multinucleate, the upper ones uninucleate. The apical cells of the developed male branches represent the spermatangia mother-cells, which cut off two to three spermatangia. The primary tetrasporangia nucleus possesses, like the other cell-nuclei of the tetraspore plant, a distinct nucleolus and a network with many small chromatin grains. Spireme stages occur in the reductions-division of the tetrasporangia nuclei in *G. corallina*.

Oceanic Algæ.‡—A. Mazza, continuing his studies of oceanic algology, discusses the Squamarieæ, comprising the genera *Cruoriopsis*, *Cruoriella*, *Peyssonnelia*; also the Hæmatophlœæ, with the genus *Hæmatocelis*, with the somewhat doubtful allies *Rhododermis*, *Erythrodermis*, *Rhodophysema*, etc. The morphology and structure of one or more species in each genus are described. In the case of *Peyssonnelia* sixteen species are thus treated, one being the type of the sub-genus *Ethelia*.

West Indian Marine Algæ.§—F. Börgesen continues his report on the marine algæ of the Danish West Indies. In the present contribution

* Die Naturw., iv. (1916) pp. 78–80. See also Bot. Centralbl., cxxxii. (1916) p. 409.

† Zeitschr. f. Bot., viii. (1916) pp. 97–123 (1 pl. and figs. in text). See also Bot. Centralbl., cxxxii. (1916) pp. 431–2.

‡ La Nuova Notarisia, xxviii. (1916) pp. 169–215.

§ Marine Algæ of the Danish West Indies. Copenhagen: B. Luno, ii. (1916) pp. 81–144.

he completes his treatment of *Liagora*, and discusses fully the species of Chætangiaceæ, Gelidiaceæ, Wrangeliaceæ and Grateloupiaceæ. Rhizophyllidaceæ are treated by Madame Weber van Bosse. New species are described and figured by each of the authors.

Sexual Organs of Laminaria.*—C. Sauvageau describes the gametophytes of *Laminaria*, which he has discovered. In a previous paper he described similar organs for *Saccorhiza*. His account is as follows :—Whatever may be the sex of the future prothallus, the embryospore of *Laminaria flexicaulis* and *L. saccharina* retains its diameter of about 5 μ. After the first or second day following dehiscence, the chromatophore having doubled itself, a very narrow tube (less than 2 μ), regular or varicose, is emitted, the extreme end of which swells up and receives the major part of the contents. The entire growth resembles a dumb-bell. The orientation of this germinating tube is independent of the direction of light, and seems to be determined by the position that the protoplasm of the beak of the zoospore occupies in the embryospore. The nucleus remains in the background, in the tube, or more often in the embryospore, and divides. One of the daughter-nuclei passes into the swollen portion, which is then cut off by a transverse wall, and it becomes the origin of the prothallus, whilst the other becomes disorganized. It would seem that the nucleus of the zoospore had to undergo sub-division in order to acquire the sexual character. The empty embryospore slowly detaches itself from the prothallus by destruction of the tube. Sometimes, however, the migration is incomplete ; the posterior nucleus does not die and the embryospore is added to the gametophyte. The swollen extremity continues to increase, and multiplies its chromatophores. Certain male prothallia are of a precocious nature ; they are minute, and gradually become covered with antheridia. Others become bushy, composed of creeping filaments, either producing sessile antheridia or emitting from most of its cells one or two erect fertile branches ; some of them throw out about fifty branchlets. The different forms occur in the same culture. The antheridia are lateral and more or less tubular, or intercalary ; uninucleate and almost colourless, they contain nevertheless one or two chromatophores much reduced and very pale. At the moment of maturity their membrane swells on the inner side of the beak and compresses the contents ; then this cork-like body is dissolved for the dehiscence. In a culture, the antherozoids are always liberated before any female prothallus has began to produce oogonia ; they are therefore useless, but. in a natural condition, this protandry is favourable to fecundation ; besides, the male prothallia remain fertile for a long time and the zoospores are emitted in great quantity, and the prothallia are contiguous and entangled.

The swollen extremity which becomes a female prothallus grows for a longer time. Sometimes it is transformed into an oogonium without previous division, and the nucleus of the oosphere is then a half-nucleus

* C.R. Acad. Sci. Paris, clxii. (1916) pp. 601–4 (figs).

of the zoospore. At other times it elongates into a filament, generally short, the cells of which afterwards grow irregularly, remain simple or divide transversely or longitudinally. All the cells of the female prothallus have the same value and each may be transformed into an oogonium, the order of transformation being independent of the respective age. It then produces an erect protuberance, perhaps two; sometimes the protuberance is very long, and in that case it often divides slowly in a transverse direction. The protuberance becomes the neck of the oogonium, about 9 μ broad. When an oogonium approaches maturity the chromatophores multiply at the distal end, which becomes tightly packed with them. Then the wall increases by swelling all along its inner surface, and particularly at its distal extremity. Finally, the compressed contents escape and remain above the oogonium, where they take a long oval form. The inconstancy of the dimensions of the oogonium cause a variation in the volume of the oosphere, which is in any case a very large body compared with the antherozoids. Dehiscence is effected by a median rupture of the swollen extremity, the edges of which at once rejoin and form a sort of thick staging on which the plantlet is to rest. If the base of the oosphere is attenuated and does not manage to emerge, the swollen edges which are prevented from rejoining hold it up on the bottle-neck, as in *Saccorhiza*. In the former case the first rhizoid will be exterior to the oogonium; in the latter it will descend into the cavity. An oogonium which has put out two protuberances, only dehisces by one of them, the other remaining a cul-de-sac. A cell underlying an empty oogonium elongates sometimes into the cavity and dehisces, while pushing aside the first plantlet. As in *Saccorhiza* the egg germinates without undergoing a resting period.

Growth in Laminariaceæ.*—Annie L. Fallis records the result of her experiments on the growth of *Laminaria*, *Agarum*, *Cymathære*, *Egregia*, *Alaria*, and *Nereocystis*. She found that the plants grow as well suspended from a raft by means of cloth strings as they do when attached naturally to the rocks by their own holdfasts. She found also that the removal of the holdfast, and even of a considerable portion of the stipes, does not affect the growth of the remainder of the plant. The removal of the tip of the blade produces only a negligible effect so long as the basal portion is left intact. Pieces of the lamina, even as small as 1 mm. square, were found to grow when placed in a cloth bag attached to a raft. In kelps having a very short stipes it was found that the region of the greatest growth in the post-juvenile stages is near the base of the lamina, the main growth of the stipes occurring during the younger stages. The kelps experimented upon grow almost twice as rapidly during the daytime as during the night. The results reported agree well with the small degree of physiological specialization of parts that is found in such genera as *Laminaria* and other leaf-like kelps.

* Puget Sound Marine Stat., Publ. i. (1916) pp. 137–55 (4 pls.). See also Bot. Gaz., lxii. (1916) pp. 332–3.

Fungi.

By A. Lorrain Smith, F.L.S.

Culture Experiments with Rhizopus nigricans.*—Arthur H. Graves has been investigating the behaviour of fungal hyphæ in relation to chemotropic stimuli. He selected the above fungus (along with some others) and watched the growth of the hyphæ very exactly. Perforated mica plates were employed, separated by two layers of medium, and various combinations of spores and chemical substances in these two layers were experimented with.

He summarizes his results thus: Many fungi exhibit a negative chemotropism toward their own metabolic products (staling substances). Positive chemotropism towards such substances as turnip-juice, cane sugar and glucose was also observed. The substances in turnip-juice exert a stronger positive chemotropic effect than, e.g. 10 p.c. cane sugar. Finally it is surmised that the distribution of a parasitic fungus in its host is due not so much to positive chemotropic stimuli as to the dominant chemotropism towards its own staling products.

Pythiacystis on Avocado Trees in California.†— Howard S. Fawcett has investigated a disease of these trees which was characterized by the exudation of gum, and, in addition, by the deposit on the surface of the injured area of a white powdery crystalline substance. The trouble occurs not only on large trees, but also on small seedlings, especially if they have been over-watered. Culture experiments were made in tubes in all of which a *Pythiacystis* (Saprolegniaceæ) was developed; and inoculation of healthy trees by mycelium from the culture tubes reproduced the disease.

Tarichium: a Genus of Entomophthoreæ.‡—The fructification of this genus is unknown. It includes a number of very uncertain forms, and is in the nature of a collective or provisional genus. G. Lakon gives a list of species that might be considered as true species, and of others that do not belong to any genus of Entomophthoreæ. He discusses the economic value of these fungi as causing diseases of insects; occasionally they have proved of great service in reducing the insect pest, but too little is as yet known of the biology of the group.

Development of the Perithecium.§—M. F. Vincens has made a special study of this subject, and he publishes the details of growth and development of a somewhat peculiar character in a *Melanospora*, one of the Hypocreaceæ. The ascogonium consisted of a globose cell borne on a stalk one to two septate. It is multinucleate, as are most of the cells of the thallus. From the stalks issue short branches which cluster round the ascogonium and form an inner wall, one-cell thick. Spiral cells

* Memoirs New York Bot. Gard., vi. (1916) pp. 323–31.
† Phytopathology, vi. (1916) pp. 433–5.
‡ Zeitschr. Pflanzenkr., xxv. (1915) pp. 257–72. See also Bot. Centralbl., cxxxi. (1916) p. 621.
§ Comptes Rendus, clxiii. (1916) pp. 572–5.

then arise from neighbouring hyphæ and form a second covering; these spirals may come in contact with the ascogonium, but no fusion was observed. Meanwhile the ascogonium divides and forms a tissue of uninucleate cells, during which time the inner wall of cells multiplies and forms a plectenchyma of multinucleate cells.

In the ascogonial tissue two neighbouring cells may coalesce and their nuclei fuse, but this phenomenon could not be considered as essential to further development. The ascogonial tissue gave rise directly to the asci, or to branches of which the ultimate cells became asci.

Sporulation in Cultures of Botryosphæria Berengeriana.*—This fungus rarely forms spores in artificial cultures, but J. Matz has devised a plan whereby he has been able to secure abundant spore productions. Plugs of wood were sterilized, well washed in water, and then infected by introducing mycelium into slits made by a sterile scalpel into the bark. The whole was then dipped in paraffin for an instant. In about four weeks pycnidia with spores were formed in great abundance on the paraffined plugs. It seems that the substitute of a coat of paraffin eliminates the moist air which ordinarily exists in culture tubes, and in this way the growth of aerial sterile mycelium is suppressed and sporulation encouraged.

Genus Meliola in Porto Rico.†—Species of this genus, according to F. L. Stevens, are among the most common of leaf-inhabiting fungi in Porto Rico; they cause conspicuous black blotches on one or both surfaces of the leaf; more rarely they spread to the stems. They are frequently overgrown by other parasites, which affect this development and render accurate determination and description extremely difficult. Many new species have been described, and a host-list, arranged in families, is appended. Stevens has described ninety-five species.

Californian Tuberales.‡—Helen M. Gilkey has recently published a revision of the Tuberales of California. She gives a preliminary account of the history, occurrence, economic importance, and of the morphology and phylogeny of the group. There are none of the edible tubers in California; none of the native species exhibit any marked odour, and that renders them valueless as condiments. The development of the genera is traced and their connexion with *Peziza* stated, the latter being also of angiocarpous origin.

In the special systematic portion, twelve genera are dealt with, one of them *Hydnotryopsis*, new to science, described from a species collected in forests in March, and previously described as a *Stephensia*. There are fourteen new species in this Californian list.

Peculiar Development in Verticillium.§—M. F. Vincens found the species as a mould on a *Russula*. It was allied to *Verticillium* by

* Phytopathology, vi. (1916) pp. 587–9 (1 fig.).
† Ill. Biog. Monogr., ii. (1916) 86 pp. (5 pls.).
‡ Univ. California Publications (Bot.) vi. No. 11 (1916) pp. 275–356 (5 pls.).
§ Comptes Rendus, lxiii. (1916) pp. 489–91.

the structure of the sporophores and to *Beauveria* by the conidial development. As to the latter the first conidium was formed at the tip of a branch, while still in position, a second conidium budded out from the hypha immediately below the terminal one. Five or six conidia might thus be formed in succession. This growth character has not, however, seemed to the author sufficient to separate the species from the genus *Verticillium*.

Septoriæ on Ribes.*—R. E. Stone has made cultural experiments with two species of *Septoria*. The first, on *R. nigrum*, has for its perfect form *Mycosphærella Grossulariæ*. He has proved that the same fungus attacks *R. rubrum*, *R. Grossularia*, and *R. cynobasti*; it has also been reported on *R. prostratum*, *R. rotundifolia*, etc. The pycnidia are mostly hypophyllous on dark ashy-grey spots; the perithecia, also mainly hypophyllous, are gregarious on dead over-wintered leaves of currant and gooseberry, and follow on the *Septonia* attack.

Septonia aurea was similarly investigated. It causes a leaf-spot on *Ribes aureum* from June to October. The perithecia, *Mycosphærella aurea* sp. n., appear on the old leaves in spring and early summer. The latter species has not been proved to pass to any other *Ribes*.

Smut Diseases of Wheat.†—W. B. Mercer describes the different diseases which have passed under the general term "smut." Stinking smut, *Tilletia Tritici*, attacks all the grains in a head of wheat, and these at the time of maturity consist solely of black spores. They germinate readily and infect the plants in the seedling stage, the germinating tube boring its way into the young shoot and advancing towards the growing point of the stem and the flower-bearing portions. The disease is spread by the dispersal of the ripe spores to other grains during the threshing or during storage.

Loose smut, *Ustilago Tritici*, also turns the grain into a mass of black spores. Infection in this fungus takes place in the early stage of flower-formation. Mercer describes the various methods employed for dealing with these diseases. The seed-grains should be cleansed from any adhering spores either by treatment with hot water or with some fungicide. The former method has generally proved to be the most serviceable and effectual.

Research as to the Influence of External Factors on the Occurrence of Cereal Rusts.‡—G. Gassner carried out a series of observations in Uruguay on this subject, testing and comparing plants living as nearly as possible in the same conditions. He confirmed the observations that old as well as young plants were subject to uredospore infection, but in the former case only up to the time when teleutospore growth began. He contrasts the duration-time of infection in a number of species attacked by *Puccinia graminis*, *P. triticina*, and *P. coronifera*.

* Phytopathology, vi. (1916) pp. 419–27 (2 figs.).
† Journ. Board. Agric., xxiii. (1916) pp. 633–43 (2 figs.).
‡ Centralbl. Bakt., 2te Abt. xliv. (1915) pp. 512–617. See also Bot. Centralbl., cxxxi. (1916) pp. 654–7.

With regard to the season of infection, the above three species vary to a slight extent. Climatic factors are important in spore dispersal, and in affecting the condition of the host-plant. In that region the influence of atmospheric moisture is not a changeable condition; there is almost no variation. Heat was found to further the growth of rusts. Other factors studied were the position of the ground, deep and damp soils favouring the rusts, and the kinds of manure used. The quantity of seed sown was without influence.

Uredineæ. — W. H. Long * has established the æcidial stage of *Coleosporium ribicola*. It was obtained by inoculating plants of *Ribes leptanthum* and *R. longifolium* with the æcidiospores of *Peridermium* from the needles of *Pinus edulis*. The resulting uredospores on the *Ribes* leaves proved to be those of *Coleosporium ribicola*, so that the æcidial stage should be called *Peridermium ribicola*.

J. R. Weir and H. E. Ernest † report a serious disease of *Pinus ponderosa* seedlings, due to *Peridermium filamentosum*, which attacked the stems. The alternate form, *Cronartium coleosporioides*, was found in close proximity, growing in great abundance on *Castilleja miniata*. As the seedlings were free from traumatic injuries, the mycelium of the parasite must have penetrated the epidermis of the host-plant. The period of development between the penetration and the development of the æcidia was about ten to eleven months.

Paul Cruchet ‡ has discovered and described two new Uredineæ in Switzerland. The first is a *Uromyces* on *Phleum Michelii*, and by a series of cultivation experiments he found the æcidial host to be *Ranunculus montanus*. He points out the differences between these stages and those of neighbouring species. The second Uredine was found on stalks of *Calluna vulgaris*. There were only uredospores, but every evidence went to prove that the fungus was a *Thecopsora*, and was named provisionally *T. Fischeri*.

P. Dietel § discusses the systematic position of *Uredo alpestris*, so far uncertain owing to the absence of the teleutospore form. He finds that there are two types of uredospore borne in distinct sori, and therefore the affinity with *Uredinopsis* is strongly suggested.

G. Jacob ‖ has written an account of the Uredines of the geranium, of which the æcidia grow on plants of that genus, while the *Pucciniæ* develop on *Polygonum*; he makes special reference to the species *Puccinia Polygoni-amphibii*. He discusses also the species of *Uromyces Puccinia* on geranium.

J. S. Bryce ¶ publishes a note on the pycnidia of *Cronartium pyriforme*, which he has observed for the first time. They occurred on

* Mycologia, viii. (1916) pp. 309–11.

† Journ. Agric. Research, v. No. 17 (1916) pp. 781–5. See also Bull. Agric. Intell. Rome, vii. (1916) pp. 759–61.

‡ Bull. Soc. Vaud., li. (1916) pp. 73–9 (4 figs.).

§ Ann. Mycol., xiv. (1916) pp. 98–9. See also Bot. Centralbl., cxxxi. (1916) p. 654.

‖ Centralbl. Bakt., xlvi. (1915) pp. 617–58. See also Bot. Centralbl., cxxxii. (1916) pp. 33–4.

¶ Phytopathology, vi. (1916) pp. 446–7.

the main stems of seedlings and saplings of western yellow pine (*Pinus ponderosa*) in California. On one of the saplings æcidia had already formed spores, while on another the spores were exuded from the pycnidia in Brazil-red drops. The infected seedlings grew in close proximity to *Comandra umbellata*, which bore the uredospores and teleutospores. From various observations he concluded that the æcidia do not develop until the season following the appearance of the pycnidia.

A. Bucheim * found a specimen of *Melampsora Lini* towards the end of April at a height of 1300–1400 m. The uredospores were growing close by the previous year's teleutospore sorus, and he considered that the uredo must have developed from the mycelium that had wintered in the host-plant. Infection experiments gave a series of forms on other species of *Linum*.

Histology of Californian Boletaceæ.†—H. S. Yates has undertaken a research on the structure of all the species of *Boletus* growing in California, his object being to extend as far as possible the knowledge of these species, to determine the details of individual species, and to compare the histology of one with another.

All of the Californian *Boleti* are terrestrial, and probably saprophytic on decaying leaves and twigs, and they all inhabit woods; none were found in open fields. Yates explains the general structure, and then gives details of the structure of each species, with special reference to the rind of the pileus and stipe and the structure of the pores.

Contribution to Fungus Biology.‡—G. H. Coons gives the result of culture experiments with *Plenodomus fuscomaculans*, a fungus parasitic on the apple. The problem to be solved was the determination of the effects of various controlled factors upon the growth and reproduction of the fungus. It was found that there was a wider range of conditions advantageous to growth than there were to reproduction. Pycnidia, for instance, were not found in the dark, but when their growth had begun in the light they would continue to develop in the absence of light, though not so vigorously. "There is therefore an inverse relation between growth and reproduction, insomuch as a strong light inhibits the normal development of mycelium." Again, pycnidia formed at temperatures between 10° C. and 30° C. At lower temperatures pycnidia do not appear, though mycelium still grows.

Oxygen is indispensable for the growth of both mycelium and fruiting bodies. Humidity delays but does not entirely suppress pycnidial formation, while it is distinctly favourable to the mycelium. More food is also required for reproduction than for vegetative growth. A favourable culture medium for inducing pycnidium-formation was a weak solution of magnesium sulphate and potassium acid phosphate in combination with maltose and asparagin.

* Arch. Sci. Phys. Nat., ser. 4, xli. (1916) pp. 149–54. See also Bot. Centralbl. cxxxii. (1916) pp. 139–40.

† Univ. California Publications (Bot.) vi. No. 10 (1916) pp. 221–74 (5 pls.).

‡ Journ. Agric. Research, v. No. 16 (1916) pp. 713–69. See also Bull. Agric. Intell. Rome, vii. (1916) pp. 749–51.

Mycological Notes.*—C. G. Lloyd has issued a series of notes and descriptions relating to a variety of fungus forms. In discussing species of *Cordyceps* he suggests that specimens from Brazil found on locusts, and considered by Hennings as new species, are probably identical with *C. sphingium*, which grows on moths and was originally collected in the West Indies. The species on scale insects are also reviewed. Lloyd has lately received plants of *Lysurus* from Australia, and takes the opportunity to sketch the history and occurrence of *L. Gardneri*. It has been introduced into America and Europe from more tropical countries, but is only an alien plant. *Paulia resinacea*, a very peculiar new Gasteromycete from Australia, is described and figured, as also a conidial clavate *Xylaria*, which is peculiar in being developed from a sclerotium. Other plants commented on are *Hydnum Henningsii*, with yellow flesh and brown teeth, from S. Africa; *Stereum elegans*, with a long tap-root, from Australia; *Irpex vellereus*, like a *Radulum* in young stages; *Exidia japonica*, with hymenial papillæ formed of fasciculate hyphæ. Species of *Polystictus*, *Guepinia* and *Bovistella* are also reviewed.

Mycorhiza of Forest Trees.†—In discussing the growth of forest tree-roots, W. B. McDougall gives the results of his observations on their mycorhizal relations. Two conditions he finds are necessary for the formation of mycorhizas: "the roots must be growing and the proper fungus must be present and in an active and receptive condition."

He concludes that as mycorhizas are produced largely by the later-fruiting mushrooms, they are formed in the autumn rather than in the spring. And he also states that these fruit bodies are usually produced after the fungi have become attached to roots. He identifies as mycorhizal: *Russula fœtentula*, for oak trees; *Scleroderma vulgare*, for limes; and probably *Laccaria ochropurpurea*, for hickory. In the case of these trees no mycorhizas were found in the spring, but they appeared after the first of July whenever the roots were growing well.

Diseases of Plantation Rubber in Malaya.‡—F. T. Brooks has published notes on the occurrence of fungus diseases of *Heæa* as observed by him; these are *Fomes lignosus*, *Polyporus rugulosus*, *Hymenochæte noxia*, with a number of microfungi, such as *Botryodiplodia*, *Glœsporium*, etc. He also describes thread blights, a fruiting stage of one having been determined as *Cyphella Heveæ* Massee. Bark diseases were also looked for, but the author failed to find *Phytophthora Faberi*, which had been recorded previously from Malaya.

Disease of Lombardy Poplar.§—G. G. Hedgcock and N. Rex Hunt have described a new fungus outbreak in the United States on this tree due to *Dothichiza populea*. It attacks the trunks, limbs and twigs of

* Cincinnati, Ohio, No. 43 (1916) pp. 589–604 (1 pl. and figs.).
† Ann. Journ. Bot., iii. (1916) p. 391.
‡ Ann. Appl. Biol., ii. (1916) pp. 209–26.
§ Mycologia, viii. (1916) pp. 300–8 (2 pls.).

both the black and the Canada poplars, and is a very rapidly growing cancer-producing fungus. The pycnidia of the fungus are formed beneath the bark, and when mature produce the spores in tendrils, at first cream-coloured, but gradually changing to a tawny-olive or walnut-brown colour. There is a suggestion—not proved as yet—that it may be a stage of *Cenangium populneum*.

The authors have traced the history and occurrence of the fungus in Europe and America, and they recommend the destruction of diseased trees. As a preventitive, cuttings should be dipped in Bordeaux mixture before planting.

Parasitic Saccharomycete of the Tomato.*—Albert Schneider describes this fungus, which was found on a tomato probably from Cuba or from Mexico. All the stages of growth and development were present on the slides that were mounted. The vegetative cells were seen to multiply by budding. The ascopores are formed in spore-sacs which result from the gametic union of two normal elliptical vegetative cells. Eight spores are formed in each sac; they are two-celled, rather slender, and taper to a point. The fungus is a true parasite, as it develops in and upon living tissues, and will not develop in the presence of decay.

Chondromyces Thaxteri.†—J. H. Faull describes this new species of *Myxobacterium*, pointing out the affinity of these organisms with the Myxomycetes, especially with the Acrasieæ, their colours being strictly comparable to the fructifications of that group. In the above species the pseudoplasmodia are yellow or flesh-coloured, the "fructifications" yellow, the stalks simple or branched. It appeared on deer-dung from Algonquin Park Forest Reserve, Ontario, and was successfully cultivated during two years. The different culture stages are carefully described.

Plant Diseases.—W. H. Tisdale ‡ has described a black spotting of tomato fruits due to a species of *Melanconium*. The spots are small, seldom reaching an eighth of an inch across, and, if independent of wounds, are confined to the superficial layers of the tomato. Wound infections involve the destruction of the deeper tissues of the fruit. The disease was easily induced by spraying with a spore-suspension in water, but in this case infection only took place where the fruits were wrapped with moist cotton after spraying. The wound type of spot was produced by inserting spores in the fruit by needle-pricks.

G. H. Pethybridge § publishes a report on investigations into diseases of potatoes during 1915. He discusses first the ordinary blight, *Phytophthora infestans*. It has been found that after a season

* Phytopathology, vi. (1916) pp. 395-9 (4 figs.).
† Bot. Gaz., lxii. (1916) pp. 226-332 (2 pls.).
‡ Phytopathology, vi. (1916) pp. 390-4 (3 figs.).
§ Dept. Agric. Techn. Instr. Ireland, xvi. No. 4 (1916) 34 pp. (16 figs.).

comparatively free from the blight numbers of potatoes are stored and pitted that are very slightly affected, and these may develop and so produce a bad pitting season. The result of planting diseased tubers was noted, and it was found that only about half of them develop, but in no instance was it found that they became a centre of infection, though probably in many cases they do give rise to epidemics of the disease. Hibernation of the mycelium in the tubers is, so far as is at present known, the only way in which the blight fungus survives from one season to the next.

The ravages due to the stalk-disease, *Sclerotinia libertiana*, and of a leaf-disease due to *Bobrytis cinerea* are described; both of these have a sclerotium stage. Another troublesome disease somewhat similar in its effect to black-stalk rot is caused by a hyphomycetous fungus, *Verticillium alboatrum*. The mycelium of the fungus penetrates into the water-conducting tissues of the plants, choking them and thus causing withering and death. When the stalks are dead, the fungus spreads from the wood vessels into the neighbouring tissues, then passes into a resting condition and turns black.

The collar fungus, *Hypochnus Solani*, has also been investigated. It was formerly known as *Rhizoctonia Solani*. It is fairly prevalent, but in Ireland it does not seem to cause any serious disease.

C. W. Edgerton * describes his method of securing disease-resistant tomatoes. He grew numbers of plants on soil that had been first sterilized, then heavily infected with *Fusarium Lycopersici*, the wilt fungus. Most of the plants took the disease seriously; those that escaped were used for further cultivation in normal soil and proved to be largely resistant to the disease.

A. Trotter † has found chestnut-trees badly infested with *Oidium Quercus* in Italy; it has also been reported on beech-trees by Farneti in the Bolognese Appennines. Trotter therefore concludes that the possible affinities of the fungus are enlarged if its identity with *Microsphæra quercina* and with *M. alphitoides* be not accepted. The special virulence of the attack was due to the formation of new shoots on trees felled out of season in the early part of July. The new shoots, sprouting about the middle of August, developed with difficulty, and were consequently in a highly receptive condition.

J. M. Murray ‡ signals the destructive character of *Polyporus Schweinitzii* in Scotch woods. It was found attacking Douglas fir and Sitka spruce in Perthshire, and Scots pine in Midlothian. It has also been recorded on larch in England. The mycelium changes the wood to a dull yellow colour, finally to dark brown, while here and there small packets of white mycelium are visible. The whole mass becomes brittle and has a turpentine odour. Remedies are suggested.

* Science, n.s. xlii. No. 1095 (1915) pp. 914–5. See also Bull. Agric. Intell. Rome, vii. (1916) pp. 751–2.

† L'Alp, ser. 2, iii. No. 2 (1916) pp. 49–53. See also Bull. Agric. Intell. Rome, vii. (1916) pp. 758–9.

‡ Trans. Scott. Arbor. Soc., xxx. pt. 1 (1916) pp. 56–7 (1 pl.). See also Bull. Agric. Intell. Rome, vii. (1916) p. 759.

L. Petri * has already stated that he has reason to believe that the "ink-disease" of chestnuts is not due to the attack of a *Coryneum*, that fungus found on the tissues being a saprophyte. He now publishes a further account of his observations, cultural and microscopic, which tend to confirm his view that the disease is caused by some one of the Polyporei. He has found mycelium in the tissues that he was able to identify with a species of *Poria* and with *Fomes Ribis*.

D. Hegyi † reports a severe attack on clover (*Trifolium pratense*) by the fungal parasite *Glœosporium caulivorum*. The plants were blackened and then entirely destroyed. The fungus spores are disseminated along with the clover seed, and as a remedy the author recommends soaking it in copper sulphate.

B. A. Bailey ‡ has recorded an instance of diseased seedling gooseberry plants being cured from disease by transplanting them to new ground, thus confirming Salmon's view that the perithecia fall to the ground and reinfect the trees in spring. Any perithecia that remain on the trees are not viable, unless under special conditions of temperature, etc.

P. Bijl § has described a "wilt" or "crown-rot" disease of carnations which is caused by a species of *Fusarium*. The rot is evident on the stem just below the soil level, and soon causes the death of the whole plant. The disease is especially virulent in South Africa. The author gives an account of his infection experiments and of the behaviour of the fungus on different culture media.

The same author ‖ has made a study of the "dry-rot" disease of maize, *Diplodia Zeæ*, otherwise known as mildew or mould. Special attention was given to the effect of diseased maize on stock, and it was ascertained that though it appeared to be non-poisonous, yet, judging from chemical substances produced by the fungus in artificial media, the mildewed maize could not be considered a healthy article of food. The spores were found to have little resisting power, and they lose viability soon after passing through the alimentary tract of animals. The fungus was easily cultivated on manure and on other artificial media. The destruction of infected maize is recommended.

A serious disease of snap beans was found by J. A. McClintock ¶ to be caused by *Sclerotinia*, which he had reason to believe was a special strain of *S. libertiana*. Cross-inoculations proved that the disease was reproduced on lettuce. Experiments on growth conditions showed the advantage to the fungus of a moist atmosphere ; it took twice as long to produce decay when the air was dry.

* Atti Reale Accad. Lincei, cccxiii. (1916) pp. 172–6 (2 figs.).

† Mèzogorz. Szemle, xxxiii. 2 (Budapest, 1915) p. 53-8. See also Bot. Centralbl., cxxxii. (1916) p. 69.

‡ Ann. Appl. Biol., ii. (1915) pp. 162–5. See also Bot. Centralbl., cxxxii. (1916) p. 121.

§ Ann. Appl. Biol., ii. (1916) pp. 267–90 (4 pls.).

‖ Dept. Agric. Union S. Africa, Sci. Bull., xii. (1916) p. 5–59 (15 pls.). See also Bot. Centralbl., cxxxii. (1916) p. 240.

¶ Phytopathology, vi. (1916) pp. 436–41 (2 figs.).

P. Kyropoulos* has investigated a disease of the seedlings of *Brassica* species. By culture experiments he obtained pseudosclerotia with *Monilia*-like cells, and by inoculation he reproduced the fungus which he names *Moniliopsis Aderholdii*.

W. Nowell † deals with diseases of lime trees in forest districts in the West Indies. These are black-root disease due to *Rosellinia bunodes* or *R. pepo*, and red-root disease caused by some undetermined fungus. The *Rosellinia* species attack the roots and collar of the trees. *R. bunodes* produces black rhizomorphic strands which penetrated the wood in all directions; *R. pepo* forms white spreading sheets of mycelium on the surface of the wood. The fungus causing red-root disease is slower in its action, it causes a soft rot of the roots, and is characterized by flat-branching strands of mycelium of a reddish colour beneath the bark.

Lichens.

(By A. Lorrain Smith, F.L.S.)

Lichen Exsiccati.‡—The first part of a work dealing with world-wide exsiccati of lichens has been issued in a separate publication by Bernt Lynge. The authors dealt with so far range from Anzi to Kœrber, being arranged in alphabetical order. Each list bears the full title, date and number of species issued with the place of publication. The author explains in his preface how necessary authentic specimens are in the determination of species. Many of the essential characters are microscopic and depend on spore and other characters.

Monograph of Norwegian Physiaceæ.§—Bernt Lynge gives an account of the nomenclature of this family, in which he comprises two genera, *Anaptychia* and *Physcia*, characterized by the dark septate spores and differing from each other in the structure of the upper cortex. He draws attention to the nitrophilous character of many members of the group. They invariably grow on or near a nitrogenous substratum and grow more quickly than most lichens.

In the systematic part of the work a complete bibliography and full anatomical details are given of the various species. The localities and substrata are carefully indicated. An exhaustive bibliography and an index of genera and species are added to the work.

* Centralbl. Bakt., xlv. (1916) p. 244. See also Bot. Centralbl., cxxxii. (1916) pp. 294–5.

† Pamphlet Imp Dept. Agric. West Indies, No. 79 (1915) pp. 7–41 (5 pls.). See also Bot. Centralbl., cxxxii. (1916) p. 295.

‡ Part I. Kristiania, 1915. See also Nyt. Mag. Naturv. liii. (1915) pp 1–112; liv. (1916) pp. 113–304.

§ Vidensk. Skr. 1, Naturv. Kl., No. 8 (1916) 110 pp. (3 pls. and 11 figs.).

Lichenological Notes.*—G. Einar du Rietz publishes the first of a series of notes and observations on lichens at the botanical museum at Upsala. He draws attention to the Swedish lichen, *Peltigera lepidophora*, and discusses the question as to whether the excrescences on the upper cortex are cephalodia or of isidiose origin. He contrasts it with *Peltigera prætexta*, the thallus lobes of which are densely beset with outgrowths.

Notes are given on several *Cladoniæ*, *Lethariæ*, and on the Swedish *Hypogymniæ*.

In a second contribution † he gives notes on some of the rare species of lichen vegetation of Öland, such as *Lecidea testacea*, *Cladonia glauca*, *Physica tremulicola*, etc.

Mycetozoa.

(By A. Lorrain Smith, F.L.S.)

African Mycetozoa.‡—C. O. Farquharson and G. Lister have published an account of African, more particularly Nigerian, mycetozoa collected by the former during a residence in that region. C. O. Farquharson contributes an account of the country and of the vegetation. Mycetozoa are most frequent in cleared localities on stumps and logs left on the ground, but some grow high up on living palms, *Hemitrichia serpula* having frequently been found on the bases of the dead outer leaves, *Physarella oblonga* on the dead female inflorescence, while *P. reniforme* seemed to be confined to the male. These species were found to be present when the trees were felled. Farquharson comments on the number of familiar British species that grow in Nigeria. *Fuligo septica* is perhaps the most frequently met with; *Stemonitis splendens* also very common in the clearings on the burnt surface of logs. On the other hand, many genera that are common in our temperate regions are wanting, such as *Trichia Badhamia*, etc.

G. Lister contributes the section, dealing with genera and species. She reviews the work previously done on African mycetozoa, and gives a list of all species recorded from that continent. Those collected by Farquharson are examined and recorded in detail with many interesting biological observations. There are two new species *Physarum digitatum* and *Diachæa radiata*, the latter having also been sent from Ceylon by T. Petch, the only records so far.

* Svensk. Bot. Tidsk., ix. No. 4 (1915) pp. 421–31.
† Svensk. Bot. Tidsk., x. No. 3 (1916) pp. 471–8.
‡ Journn. Bot., liv. (1916) pp. 121–33 (1 pl.).

Schizophyta.

Schizomycetes.

Streptothrix of Rat-bite Fever.*—F. C. Blake reports the case of a woman who had been bitten on the finger by a rat. She was admitted to hospital two weeks later with fever, severe pains, and marked prostration. Death occurred fifteen days after admission. A blood examination on the first day gave an abundant growth of a streptothrix, both in aerobic and anaerobic culture. A second blood culture, four days later, was negative, but the organism was again recovered at the autopsy. The organism gave positive agglutination with the patient's blood-serum, before death, in so high a dilution as 1 in 320. It was very slightly pathogenic for rabbits and white rats, and not at all for guinea-pigs. The streptothrix, which was Gram-negative, may be identified with the *Streptothrix muris ratti*, which has been described by Schottmüller as the causal organism of rat-bite fever.

Etiology of Typhus.†—W. J. Penfold has isolated a new coccus from the lesions of typhus fever. The organism is Gram-positive, gives pure plates of green colonies on pepton blood-agar, grows at room temperature, and does not liquefy gelatin. The author's summary and conclusions are as follows :—

Summary.—1. The same coccus was found in the blood and urine of two patients suffering from typhus, and also in the urine of a convalescent of nine-days' standing. 2. European typhus blood causes the same types of fever reaction in monkeys as American and North African typhus. 3. The coccus above mentioned has been isolated from the blood of infected monkeys. 4. Fever has been produced after a six-days' incubation by the inoculation of a pure culture of the above coccus into two monkeys. 5. The above coccus is fairly closely related to cocci described by other authors, as far as the published data admit of a comparison. 6. The coccus is not injured by long exposure to low temperature, viz. 2° C.

Conclusions.—1. The actual organism causing typhus is still not fully decided, but the balance of evidence available is in favour of its being due to a coccus. 2. The claims of Plotz to have discovered the cause of the disease are largely discounted by the contradictory nature of his publications. 3. Cocci have been found in the blood so frequently by independent and competent observers, that the use of these cocci tentatively as a prophylactic vaccine appears to be indicated.

Contribution to the Etiology of Gas-gangrene.‡—Weinberg and P. Seguin have isolated an organism, which they describe under the name of *Bacillus histolyticus*, from the lesions of war wounds. This

* Journ. Exper. Med., xxiii. (1916) pp. 39–60.
† Trans. Soc. Trop. Med. and Hygiene, ix. (1916) pp. 105–15.
‡ Comptes Rendus, clxiii. (1916) pp. 449–51.

organism, which is itself incapable of causing gas-gangrene, plays an important role in the etiology of certain cases of gas infection, and provokes profound lesions of the vessels and muscular tissues. The following is a short description of the organism :—

Diplobacillus ; length 3–5 μ, breadth 0·5–0·7 μ ; very motile in exudates and in young cultures ; large subterminal endospores. Easily stained by Ziehl ; numerous flagella. Strict anaerobe ; some strains very difficult to cultivate. Develops well in broth and sugar-broths. Old cultures slightly evil-smelling. Slowly digests white of egg and rapidly liquefies gelatin. Milk is coagulated in from twenty-four to forty-eight hours, and the clot is digested in from eight to fifteen days in the incubator. The colonies in deep glucose agar are arborescent, and gas is not produced in the medium. *B. histolyticus* is pathogenic for the guinea-pig, mouse, and rabbit, and feebly so for the rat.

MICROSCOPY.

A. Instruments, Accessories, etc.*

(3) Illuminating and other Apparatus.

Lieberkühns.†—E. M. Nelson writes that there is an old-fashioned piece of apparatus which probably many microscopists have heard about, but few seen in use; the Lieberkühn. From the forties to the seventies of last century lieberkühns (which were called "cups") used to be supplied with their respective object-glasses, much in the same way as they were in pre-achromatic times.

Although they appear so very simple, both in theory and in construction, they are, nevertheless, very tricky things to use; therefore, when anyone employs a lieberkühn they should know how to get the best results from it; but the text-books may be searched in vain for help or assistance upon this subject. It is probable that it was due to the ignorance both of the method of employment and of the efficiency of the lieberkühn that it has fallen into disuse.

With opaque objects in dry mounts, or not mounted at all, there is not much difficulty, and the observer can hardly go wrong. For these daylight, or artificial light by edge of flame parallelized by bull's-eye, may be used from the plane-mirror. But it is with objects mounted in a medium where the trouble comes in. Let us take an example:—A spread slide of forams in balsam—objective 1 in. or 1½ in., with lieberkühn. Now, first, it must be understood that there are opaque and semitranslucent forams, and that each of these kinds will require a different treatment. Let it be assumed that the lamp with attached bull's-eye and plane-mirror have been set up in position; then next it is necessary to place a Lister's dark-well in the substage to stop out the axial light. A Lister's dark-well consists of a piece of tube ½ in. long, one end having a plug fastened to a stem by which it is attached to a holder in the substage. The upper end of the tube should have a sharp edge, and the inside of it should be blackened. Flat stops and paper stops are not effective, because the lieberkühn throws down a good deal of light, some of which is likely to be reflected back again, and this will spoil the dark ground; but a Lister's dark-well, with a

* This subdivision contains (1) Stands; (2) Eye-pieces and Objectives; (3) Illuminating and other Apparatus; (4) Photomicrography; (5) Microscopical Optics and Manipulation; (6) Miscellaneous.

† English Mechanic, Dec. 1, 1916, p. 370.

long tube and fine edge, stops all reflections. These Lister's dark-wells were generally supplied in three sizes; but in later years the tubes were made shallower, and they were not as effective as the old pattern. Having got the dark-well in position, and supposing we wish to examine an opaque foram, we focus down upon it and raise the lieberkühn until we have the light, which is an image of the bull's-eye, concentrated brightly upon the object.

Secondly. We wish now to see one of the transparent forms; but if we look at it with the adjustments as they were used for the opaque foram, the transparent foram will be so dark as hardly to be visible. What, then, must be done? All that is necessary is to focus down the lieberkühn, and when the correct position is reached the transparent foram will shine up quite brightly. So we see that with the same slide and same object-glass and lieberkühn different forms of forams require different foci of the lieberkühn. These remarks apply equally to polycystines and diatoms, as well as to various parts of insect structures, etc. These important facts have never been published anywhere, neither in text-books, nor in any paper read before the societies; and yet they form the basis for the proper use of a lieberkühn! The theoretical explanation is that the spherical aberration of the lieberkühn mirror enables one to illuminate the opaque object by light which falls more or less directly upon it from above—i.e. light of small angle from the central portion of the lieberkühn; but when the shorter focus of the lieberkühn is employed, the semi-transparent object is illuminated by wide-angled oblique light from the outer zone of the lieberkühn. Daylight gives only poor results on objects mounted in a medium. In conclusion, we have to discuss the relative merits of illumination by lieberkühn and by condenser with stop. Some may think that they are in effect the same, and may therefore be used indiscriminately; but such, however, is not the case. Let two Microscopes be provided—say Wenham binoculars—as similar as possible, with two 1-in. objectives, one with a lieberkühn and the other with a condenser and stop; obtain two similar slides of forams, and select for examination similar specimens. The image with the condenser and stop may be very brilliant, and may take in those who do not understand the way to interpret a correct image: but a little thoughtful attention will show that the condensed image has a great deal of the underneath part of the foram confusing the image of the upper part, which with the lieberkühn image is not the case.

Caution.—All lieberkühns are not properly made or fitted. The objective should have a long, smooth snout, and the lieberkühn should slide smoothly upon it, and, what is very important, have sufficient range of motion.

The objectives and lieberkühns as made by Messrs. R. and J. Beck are excellently arranged. Some lieberkühns will be found to have such long tubes that they will not focus the light upon an opaque foram, while others are so deeply cupped that they touch the slide before they focus the light. The first fault is easily remedied by reducing the length of the tube, but the second must be corrected by the maker.

Finally, it can be stated that anyone who has not seen a Eupodiscus

Argus with a lieberkühn has never properly seen the diatom at all! This diatom requires the lieberkühn raised; but an *Actinocyclus Ralphsii*, a *Navicula lyra*, and a *Triceratium favus* require it to be depressed. A coarse *Navicula lyra* can be dotted, and the secondaries on a coarse *Triceratium* seen with a two-third lieberkühn, both being balsam mounts.

B. Technique.*

(1) Collecting Objects, including Culture Processes.

New Solid Medium for the Isolation of the Cholera Vibrio.†—H. G. Gibson recommends the use of a medium which consists of agar 30 grm., pepton 10 grm., starch 10 grm., and sodium bicarbonate 1·5 grm., litmus, water to 1000 c.cm.; the starch being added after solution and clarification of the other ingredients and the litmus after sterilization, which should be by the fractional method. A final reaction of 0·2 to phelolphthalein should be aimed at. As the cholera vibrio attacks starch with the formation of acid, colonies growing on this medium are distinguished from all others (with the exception of certain diphtheroids and water vibrios which also attack starch, though not so rapidly) by acquiring a faint pink colour. Fæces are plated out directly on the medium and a search made for pink colonies at the end of eighteen hours.

New Culture Medium: "Orange Agar." ‡—R. Dujarric de la Riviere points out that the addition of fruit juices—orange, for example—to agar media favours the growth of micro-organisms. 125 c.cm. orange juice is added to 75 c.cm. pepton broth (Martin). The mixture is autoclaved at 112° C. for twenty minutes, and is then filtered through Chadrin paper to remove the bulky precipitate that forms. The filtrate is very clear and of a yellow-gold colour. Agar is added as required to this stock solution in the ordinary manner for the preparation of agar media. Orange agar is acid, but can be rendered alkaline by the addition of soda solution. Alkaline orange agar is a very good medium for the cultivation of bacteria. *Bacillus typhosus* and *B. diphtheriæ*, for example, grow with the greatest ease and give a much more luxuriant growth than is the case with controls cultivated upon ordinary agar. Acid orange agar, on the other hand, has been found to favour the rapid and abundant growth of various species of fungi either obtained from nature or from artificial cultivations.

* This subdivision contains (1) Collecting Objects, including Culture Processes; (2) Preparing Objects; (3) Cutting, including Imbedding and Microtomes; (4) Staining and Injecting; (5) Mounting, including slides, preservative fluids, etc.; (6) Miscellaneous.

† Brit. Med. Journ., ii. (1916) pp. 454–5.

‡ C.R. Soc. Biol. Paris, lxxix. (1916) pp. 843-4.

(3) Cutting, including Embedding and Microtomes.

New Method of Embedding.*—J. Salkind points out that an aqueous *sol* of arabin, treated with acetate of lead and exposed to the action of ammonia vapour, is transformed into a *gel*, which forms an admirable embedding material for the preparation of thin sections. A quantity of cherry-gum (white for preference) is dissolved in double its weight of distilled water. After filtration, add one-third volume of sub-acetate of lead solution ("extrait de Saturne") with the addition of 5 p.c. acetic acid crystals. The resulting solution, which has the appearance of collodion, is placed in a corked receptacle and the piece of tissue required to be embedded dropped in. After a sufficient lapse of time (twelve hours for each millimetre thickness of specimen), the cork is removed and the "lead-gum" allowed to evaporate to the consistence of concentrated celloidin. The specimen is placed in a large drop of this solution (or in a paper box, etc.), and submitted to the vapour of commercial ammonia. The substance hardens rapidly and a block resembling hyaline cartilage is obtained. The block, after being trimmed, is stuck to the platform of the microtome by means of a little "lead-gum" which is then hardened with ammonia gas. When cutting the sections, the block is moistened with 1 in 100 salt solution, in which solution the sections are received. The sections are fixed on the slide by a modification of Olt's method. The advantages claimed for this method are: the action of fat solvents is avoided (as opposed to the paraffin or celloidin methods); there are no variations in temperature (as obtains in the paraffin or gum gelatin methods); and there is no hardening action of alcohol or acetone upon certain organs (skin, cartilage, eggs, eyes, and entire insect preparations).

Preparation of the Knife for Section Cutting.†—Albert Newton says that cutting sections by means of a hand microtome can never be a theoretical success, on account of the number of possible and probable errors we always encounter. All these errors can be minimized by care, and as a result hand section cutting is the best method we know of at the present time for some materials. The most likely error is in the knife rocking when passing through the section; this can be avoided by having the microtome top perfectly level and the knife cutting edge and back both in the same plane. The microtome top is not difficult to keep straight by the following means:—Take a piece of plate-glass and put on it a mixture of water and brass-finisher's sand, keep it in a sloppy condition, and rub the microtome top backwards and forwards until the top has a good bearing surface and is level. On no account use emery powder, as the emery particles embed themselves in the brass table, and will afterwards spoil the knife. To straighten the knife the same plate of glass can be used, but very fine carborundum powder or emery in place of the brass-finisher's sand on account of its quicker cut. If the knife is twisted, grind the back of the blade on an emery wheel

* C.R. Soc. Biol. Paris, lxxix. (1916) pp. 811–2.
† Trans. Manchester Micr. Soc., 1915, p. 61.

until the twist is taken out; if twist is once taken out it should always remain straight. When sharpening a knife it is rubbed away more at the centre of the blade than at the ends, so it is necessary from time to time, when the blade gets hollow, to rub it on the glass plate to make level. In sharpening use a whetstone of good quality and as broad as the knife blade is long, if you can get it, and keep the stone level by rubbing it on the glass plate with emery and water. After flooding the stone with water or oil, place the knife flat on it and rub the knife away from you with the back nearest to you and the edge away—that is, the edge first in the direction of travel—until you get to the end of the stone, then turn the knife over on the other side of the blade, this time the back away and the cutting edge towards you, and draw the blade along the stone towards you until you get to the other end of the stone. Remember always to keep the cutting edge in front whichever way you rub. Keep the stone covered with water or oil, and a sharp edge should be obtained. For stropping use a strop fastened to a flat board, and work the knife as a barber does when sharpening a razor.

(4) Staining and Injecting.

Preparation and Staining of Material for Mitosis.* —A. E. Openshaw says that instructive preparations for the study of mitosis may be obtained from the developing anthers of any of the ordinary varieties of cultivated lilies or from the root-tip of the onion. The anthers from the immature bud should have the tips at both ends cut off so as to allow of quick penetration of the fixing fluid to the developing pollen mother-cells. A solution of .1 p.c. each of chromic and acetic acids, or Fleming's weaker solution, may be used, and both are also suitable for the root-tip. An onion placed in a hyacinth-glass will soon provide plenty of material. About a ¼ in. of the tip should be cut off and placed immediately in the fixative. After fixation for about twenty-four hours the material should be washed free from all traces of fixative, and passed through a series of alcohols of graduated strengths, and then celloidinized. The sections may be stained by Delafield's or Haidenhain's hæmatoxylin, or Mayer's heam-alum, and very effective double-stained preparations can be obtained by safranin and aniline picrate. There is considerable variation and elasticity as to the time for allowing the stain to act, and it is advisable to make experimental trials, say to begin with, five minutes for Delafield or Mayer, and for Haidenhain half an hour, in the mordant, and two hours in the stain. With the double stain the safranin should be allowed twenty-four hours, whilst a few minutes should suffice for the aniline picrate.

Hæmatoxylin Stain.†—A. G. Hornyold communicates the following hæmatoxylin formula which he has used for some years with excellent

* Trans. Manchester Micr. Soc., 1915, p. 63.
† Lisbon, 1916.

results, and which is also very cheap and easy to prepare: Solution I., hæmatoxylin 0·7 grm., absolute alcohol 20 c.cm. Solution II., alum 0·35 grm., distilled water 60 c.cm. The two solutions are mixed and exposed to light in a window for three to four days, then 20 drops of tincture of iodine are added and the stain is ready for use. The sections are stained for five to ten minutes and are coloured red-brown. They are then differentiated in 70 p.c. alcohol acidulated with a few drops of acetic acid. The sections then turn blue. This is a good nuclear stain and is recommended for use after fixation with Flemming or any other formula containing osmic acid.

Relief Staining for Bacteria and Spirochætes.*—T. H. C. Benians has devised a rapid and simple process to obtain a uniform blue field from which the organisms stand out in sharp relief. The whole procedure occupies only a few moments. A small drop of a 2 p.c. aqueous solution of Congo red is placed on a slide and a very small quantity of the bacterial culture or of the exudate to be examined is rubbed into it with a platinum wire; the drop is then spread out into a tolerably thick film either with wire or by means of another glass slide. The film is allowed to dry and then washed over with a 1 p.c. solution of HCl in absolute alcohol. It is dried in the air and is then ready for examination.

(5) Mounting, including Slides, Preservative Fluids, etc.

Mounting in Fluids.†—W. Cookson makes the following remarks on mounting in fluids: Run a ring of brown cement on the glass slip slightly smaller than the cover-glass to be used, then let dry thoroughly; build up this ring to the required depth by successive rings, or place on a ring of tin, glass, or vulcanite, and superimpose several rings to the depth of the object to be mounted, taking care that each ring of cement is hard before running another one on. It is better to have a stock of cells of various depths ready in hand. Then ring over the brown cement ring with gum dammar in benzol, using as little as possible, but covering the brown ring evenly; lay aside for a little while to allow benzol to evaporate until the ring becomes tacky. Place in the centre the object to be mounted, flood with the mounting media, and cover with the cover-glass, breathing on same so that when the cover-glass is dropped slowly on the mount it will not flush out with the superfluous media; put spring clips on from each end of the slip to the edge of the cover-glass, covering both cover-glass and slip, let this thoroughly harden, and if necessary run another or more rings over this, and then finish as required.

(6) Miscellaneous.

Pathogenicity of Giardia (Lamblia) intestinalis.‡—H. B. Fantham and A. Porter have arrived at the following conclusions with regard to

* Brit. Med. Journ., Nov. 25, 1916, p. 722.
† Trans. Manchester Micr. Soc., 1915, p. 60.
‡ Brit. Med. Journ., ii. (1916) pp. 139–41.

Lamblia pathogenicity. The human cases under observation were from Flanders and Gallipoli, while kittens and mice were used in the animal experiments. *Giardia* (*Lamblia*) *intestinalis* is pathogenic to man and is capable of producing diarrhœa, which may be persistent or recurrent. The virulence of the parasite varies, and Lambliasis occurs in tropical and non-tropical countries. The Lamblia cysts can remain infective for some time. Lambliasis occurs in rodents, especially rats and mice, and can be of human origin. The influence of rats and mice in the spread of Lambliasis has been noted by Noc and Mathis. Lambliasis may also be produced in cats and may be transferred to man from these animals. As a result, rodents may be reservoirs of Lambliasis—which fact should be borne in mind in considering the question of Lambliasis on the Western Front.

Agglutination of Dysentery Bacilli.*—Jacobitz states that in the blood of persons inoculated with typhoid and cholera vaccines, agglutinins against Shiga's bacillus occur in a small number of cases, but they are also found in uninoculated persons. So far as his observations go they do not favour the view held by other investigators that inoculations with typhoid and cholera vaccines cause the production of agglutinins against *Bacillus Dysenteriæ* (Shiga), but that on the other hand an attack of typhoid fever does appear to exert an influence in this direction. The author has not seen Shiga agglutination in a higher dilution than 1 in 50 by the serum of persons who have never had dysentery, and only coarse clumping must be taken as specific. The test-time taken is twenty hours. Given a suitable culture, the macroscopic test, coarse clumping, and a dilution above 1 in 50, then a positive agglutination test points to an infection with Shiga's bacillus, even in a man inoculated with typhoid and cholera vaccines. These considerations apply in the case of *B. dysenteriæ* (Flexner-Y.), with the proviso that the dilution of serum must be greater than 1 in 100.

Agglutination Reaction in Leprosy.†—W. H. Harris and J. A. Landford have tested sera derived from cases of leprosy at the Louisiana Leper Home, and from rabbits intensively immunized, with a view to testing the agglutinability of *Bacillus lepræ* and allied organisms. Five strains of *B. lepræ* (Clegg, Currie, Brinkerhoff, Bayon and Duval), human, bovine and avian tuberculosis, *B. phlei*, Moeller's mist bacillus and acid-fast cultures of Korn and Karlinski were employed. An emulsion of Hansen's bacillus from a human nodule was also used. The conclusions arrived at were as follows :—The agglutinin present in the serum of the human subject affected with leprosy is usually low in titre and inconstant in its action. The employment of this procedure, therefore, has proved of no avail in striving to authenticate any of the various cultures isolated from the leprous lesions as the causal organism of human leprosy. The sera derived from rabbits inoculated with various bacillary antigens yield agglutinins likewise inconstant in amount and erratic in their

* Berlin Klin. Woch, liii. (1916) pp. 718–9.
† Journ. Med. Research, xxxiv. (1916) pp. 157–67.

action. Sera derived from these inoculated animals do not serve to differentiate the various species employed in these experiments, but suggest a group relationship. Until some further refinement in these procedures is devised but little reliability can be placed upon this type of test as a means of identification of any culture isolated from the lesions of leprosy as the bacillus of Hansen.

Identification of the Tubercle Bacillus in Organic Fluids.*
H. Bierry gives the following methods of concentrating tubercle bacilli present in the body fluids :—

Blood.—One volume (10 to 15 c.cm.) is added to one volume of soda solution (NaOH one part in 100). Make homogeneous by heating at 35°–40° C. To one volume of the mixture add three volumes of distilled water. Empty into a glass cylinder furnished with a rubber cork. Add acetic acid (1 in 100), drop by drop, shaking the while. Each drop of the acid causes a precipitate, which dissolves on shaking. Keep on adding the acid until a slight permanent precipitate is formed. Centrifuge; decant the supernatant fluid, and spread the deposit on slides. Add acetic acid solution to the decanted fluid until a precipitate is formed; centrifuge afresh, and make slides with the deposit as before. The preparations are placed on a warm plate. Warm each slide slightly, and spread a thin film with another slide. (This is the most delicate part of the operation.) The preparation takes on the appearance of varnished glass. Fix and stain by Ziehl-Neelsen. The stain should not be poured directly on the slide, but on a small rectangular piece of blotting-paper placed upon the preparation.

Pleural Exudate.—One volume of pleural exudate (10–15 cm.) is added to one volume 1/100 NaOH solution. Make homogeneous at 35°–40° C. Acidify and centrifuge as before. The final preparation should be of the appearance of muffed glass.

Cerebro-spinal Fluid.—Proceed as above. If the fluid contains much albumen, add one volume of distilled water.

Elastic Fibres.—The presence of elastic fibres in the expectorations indicate the destruction of the pulmonary parenchyma. They are not injured by the above procedure, and may be found, if present, in the preparations stained with Ziehl-Neelsen.

Making Zoological Specimens Transparent.†—The method is simplicity itself. The organism to be preserved is treated to a preliminary dehydration similar to that employed for Microscope specimens followed by deflation with an air-pump. It is then impregnated with and immersed in a liquid whose refractive index is equal to the average index of the solid matter. The liquid is a mixture of methyl-ether, salicylic acid, and benzol benzoate. By varying the proportions of this mixture a range of refraction index is obtained quite equal to that of the organisms to be embalmed. The containers are rectangular jars made of a special glass of variable index, fixed in each

* Comptes Rendus, clxiii. (1916) pp. 618–21.
† Scientific American, through English Mechanic, civ. (1916) p. 304.

case to correspond with that of the index. These are held in place by suitable supports, and a small air space is left beneath the sealed cover to care for expansion. Entire arms and legs are put up by this process, the far side being as distinct as the near one. The arterial and venous are differentiated by injection of red and blue fluids of appropriate refraction index.

In 1910 O. W. Wentz exhibited before the Society two small animals and a bone in which the internal structure was exhibited without alteration of the exterior.* In this Journal, 1900, p. 1, there is a paper by H. C. Sorby, F.R.S., on "The Preparation of Marine Worms as Microscopical Objects," the chief intention being to demonstrate the blood-vessels.

Metallography, etc.

Micro-structure of Electro-deposited Copper.†—H. S. Rawdon has studied the micro-structure of copper electrotype plates and its variation with different conditions of deposition. Three types of structure are noted. 1. With low current densities, e.g. 0·41 amperes per square foot, the crystals are large and well formed except at the surface of the initial deposit, which is finely crystalline. 2. With higher current densities, e.g. 0·57 amperes per square foot, the crystals become longer and sections have a columnar appearance under the Microscope. Isolated crystals show twinning. 3. With still higher current densities, e.g. 0·73 amperes per square foot, the structure is much broken up and twinning of crystals very common. These three types of structure are illustrated by photo-micrographs. The crystals are twinned at right angles to the direction of "growth," all the twinned layers being parallel in any one crystal. The twinning of crystals requires the application of force, and it is considered to be brought about by the rotation of crystal units by the side-pressure of neighbouring crystals during "growth" of the deposit. These mutual side-pressures must attain a certain value before twinning occurs. In all other cases the metal remains in a state of stress analogous to the condition of a "cold-worked" metal. The mechanical properties of the deposit will therefore be affected by the conditions of deposition. Hardness measurements made on the inner layers (adjacent to kathode) and outer layers of deposits confirmed this view. The inner layer where the crystals are invariably broken up owing to interference during growth is decidedly harder than the outer layer. Further support to this view was obtained by annealing different deposits. Recrystallization upon annealing of copper only occurs if the metal has previously been strained, and is nearly always accompanied by the twinning of crystals. Samples corresponding to the first type of structure were annealed for two hours at 210° C. The large crystalline parts of the deposit showed no appreciable change in crystal size or arrangement. The initial thin layer of fine crystals had, however,

* See this Journal, 1910, pp. 395, 397.

† Met. and Chem. Engineering, xv., No. 7 (1916) pp. 406-8 (7 figs.).

recrystallized, and showed frequent twinning of the crystals A sample corresponding to the third type of structure, after similar annealing, had entirely recrystallized, the structure being similar to that of cold-worked copper after annealing. Micro-photographs are given to illustrate these annealing effects. The etching was done with 1 – 1 ammonium hydroxide followed by immersion in hydrogen peroxide.

Iron-carbon-silicon Alloys.*—J. H. Andrew has taken cooling and heating curves of different iron-carbon-silicon alloys, supplemented by micro-examination of variously treated specimens. The alloys were obtained by melting a pure pig-iron with different amounts of 95 p.c. ferro-silicon. The effect of adding silicon to an iron containing 3·5–4 p.c. carbon is to raise the melting-point at first, but further additions lower it, the maximum occurring at 3 p.c. silicon. The pearlite change-point is rapidly eliminated, and with 4·5 p.c. silicon is not shown in the cooling curves. The Ar_{2-3} point is also raised, but not so readily. With 10 p.c. silicon it is raised to the freezing-point, and the cooling curve shows but one arrest corresponding to the freezing of the alloy. This would explain the insolubility of carbon in high silicon alloys, the iron being in the α-state, and therefore unable to dissolve carbon. A photo-micrograph is given of an alloy containing 2·52 p.c. carbon and 9·86 p.c. silicon, showing no pearlite, the whole mass being composed of silico-ferrite and free graphite. Other photo-micrographs are given of alloys quenched from just below the freezing-point, which show that even with ternary alloys as high in silicon as 10 p.c., carbide (either carbide of iron or carbo-silicide of iron), and not graphite, separates from the melt, and can exist undecomposed down to about 1100° C. By prolonged annealing, at 600° C., of an iron-carbon alloy consisting entirely of pearlite, the carbide was progressively decomposed into α-iron and free carbon. The presence of silicon greatly acilitates the resolution of the carbide.

Structure of Copper-zinc and Copper-tin Alloys.†—In a general review of our knowledge of the constitution of the copper-zinc and copper-tin alloys, the results obtained by the micrographic method of study are set forth in detail by W. Broniewski, and are compared with the results obtained by other methods of study. The cumulative evidence of the results, as a whole, point to the existence in copper-zinc alloys of the three compounds, $CuZn$, $CuZn_2$, and $CuZn_6$; and in copper-tin alloys of the three compounds, Cu_4Sn, Cu_3Sn, and $CuSn$.

* Iron and Steel Institute Carnegie Scholarship Memoirs, vii. (1916) pp. 1–17 (15 figs.).
† Rev. de Métallurgie, xi. (1915) pp. 961–89 (19 figs.).

PROCEEDINGS OF THE SOCIETY.

AN ORDINARY MEETING

OF THE SOCIETY WAS HELD AT NO. 20 HANOVER SQUARE, W., ON WEDNESDAY, DECEMBER 20TH, 1916, MR. E. HERON-ALLEN, F.L.S. F.G.S, ETC., PRESIDENT, IN THE CHAIR.

The President having announced that Mr. Rousselet had donated to the Society a Sliding Stage of his own design, a Stage-Vice by Ross, and a complete series of the papers on the Rotifera and kindred subjects which he had communicated to this and other Societies, a vote of thanks was accorded by acclamation.

Mr. A. Bacot, F.E.S., contributed a note on "The Effect of the Presence of Bacteria or Yeasts on the Hatching of the Eggs of *Stegomyia fasciata* (The Yellow Fever Mosquito)," which may be summarized as follows:—

The eggs of *Stegomyia fasciata* are small, dark, spindle-shaped objects of 0·6 to 0·7 mm. in length, having a strong chitinous shell. The bosses with which the shell is studded are not structural excrescences of the shell but thickenings of or pockets in a delicate outer envelope. Sections of the eggs, both before and after extrusion from the body of the female, show that the substance forming the bosses is stained by hæmatoxylin; most probably it is of a gelatinous nature. The eggs are laid singly, either on the surface of the water (usually so close to its margin as to become stranded by capillary action) or on the wet margin itself. Moist conditions after laying seem to be essential to incubation, which takes a period of thirty or forty hours, by which time the larvæ are fully developed within the egg.

In this stage the eggs retain their vitality, when dry, for long periods, four or five months being usual, while under exceptional conditions a small percentage may survive and hatch after a period of twelve months. When dry eggs are immersed in water the hatching of a given batch is frequently distributed over a considerable period of time; this is especially apt to occur if the water has a low organic content. Under such conditions hatching may be delayed for weeks or months, in two instances eggs hatched after five month's immersion.

Certain stimuli cause dormant eggs to respond by hatching. A fall of temperature of 6° to 10° F. will usually cause a percentage of these resistant eggs to hatch ; as a rule, however, the larger proportion fail to respond to cooling. The addition of foul, contaminated fluid to the receptacle in which such eggs are lying results in all or a very high percentage of the dormant eggs hatching, frequently within five or ten minutes. In collaboration with Dr. E. E. Atkin, of the Lister Institute, a considerable number of experiments in connexion with these phenomena have been carried out. After sterilizing the eggs and transferring them to tubes containing sterile fluids, it was found that the eggs respond most readily to the introduction of living yeasts or bacteria ; hatching followed the introduction of a sterile autolized extract of brewer's yeast. Killed cultures of bacteria and sterile watery extract of brewer's yeast exerted a much feebler stimulus, and in the case of strongly resistant eggs caused only a small percentage to hatch, and in some instances failed entirely. In such cases the introduction of the living yeast-cells or living cultures of bacteria (e.g. *B. coli*) never failed to bring about the speedy hatching of the resistant eggs. Sterile filtrates of bacteria were less effective than killed cultures.

The addition of sufficient dilute acid to cause the same or a somewhat stronger colour reaction than did a bacterial culture which caused the eggs to hatch was ineffective. The addition of alkaline solutions was either without effect or caused only a small percentage of larvæ to emerge, whereas when a little of a bacterial culture was added to the containers the eggs which failed to respond to the alkaline solutions hatched in large numbers within a few minutes.

The most reasonable explanation of the phenomena would seem to be the stimulus by smell, or some closely analogous sensation, of the larva, followed by active use of its egg-breaking appliance.

On the motion of the President a cordial vote of thanks was accorded to Mr. Bacot for his exhibit and demonstration.

On the invitation of the President, **Professor Hickson, F.R.S.**, then delivered an address on "Some Sedentary Foraminifera," in which he said that the small round red disks frequently found attached to dead shells, to the base of corals, or to marine weeds of the semi-tropical and tropical seas of the world had until recent years been usually referred to the same species of Foraminifera known as *Polytrema miniaceum*. When these disks were captured alive and carefully preserved they were frequently found to be the bases of small knobbed or branching coral-like growths from 10–20 mm. in height, showing a very great range of variability. The accounts given by Max Schultze and Carpenter of the structure of Polytrema were so different from each other that it is quite evident that they are descriptions of two different species of Foraminifera. Nevertheless, Schultze stated in a subsequent paper that he had examined Carpenter's specimens and had come to the conclusion that they should be referred to the one species, *P. miniaceum*. The lecturer showed that the description given by Schultze applied to specimens of *P. miniaceum* from the Mediterranean Sea, but the description given by Carpenter applied to specimens of a sedentary Foraminifera, to which he (Professsor

Hickson) had given the new generic name Homotrema,* from the West Indies and some other localities.

The two genera could be quite easily distinguished from each other by surface examination. In Polytrema the surface was perforated by two kinds of pores, the larger pillar pores (of Merkel) and numerous very minute foramina. In Homotrema there were no pillar pores, and the foramina were confined to small round or oval areolæ which were convex outwards and surrounded by perfectly solid boundaries of skeletal structures. Other constant differences between the two genera were described.

Both genera seemed to be widely distributed in the Pacific and Indian Oceans, and might be found side by side, bnt hitherto no specimens of Homotrema had been found in the Mediterranean Sea, where Polytrema was abundant ; and no specimens of Polytrema have been found in the waters of the east coast of the American Continent or in the West Indies.

Another sedentary Foraminifer described was the form previously known by the name *Polytrema cylindricum* Carter. This was also shown to be the type of a new genus, Sporadotrema. A large collection of specimens of this genus were obtained by Professor Stanley Gardiner in the Indian Ocean. They were usually of great size—as compared with specimens of Homotrema and Polytrema—and were frequently yellow or orange in colour, although specimens of the red colour of the other two genera did occur. The surface character that distinguished the genus from the other two, was that the foramina were large, scattered, variable in size, and were not aggregated in areolæ in the older parts of the stock as in Homotrema. There were no pillar pores as in Polytrema.

After a brief reference to the second species of this genus—*Sporadotrema mesentericum*—attention was called to some very large specimens of *Gypsina plana* from the Indian Ocean.

Some of the specimens of this species were found to reach the gigantic size of four inches in diameter. They formed thin encrusting sheets, layer over layer on a basis of dead coral. An examination of the structure of these layers showed an extraordinary variability in the size of the chambers and in other characters. This variability was in all probability an adaptation to the variable nature of the substance over which the specimens spread, and rendered a subdivision of the species into discontinuous specific groups an impossibility, as in so many other forms of sedentary life.

Certain features of these recent sedentary Foraminifera were then compared with those exhibited by the ancient group of fossils—the Stromatoporidæ—and the opinion was expressed that, in conformity with the views of Kirkpatrick, the Stromatoporidæ were probably closely related to the Foraminifera.

In the presence of the "initial chambers" of Polytrema, Homotrema and Sporadotrema, there was reason to believe that they were not directly descended from a sedentary ancestor, but had secondarily acquired the sedentary habit after a previous free existence.

* Trans. Linn. Soc., 1911, **14**, p. 3.

In *Gypsina*, however, these initial chambers did not occur, and it was possible that this genus was always sedentary and encrusting in habit. The lecturer regarded the sedentary habit as the most primitive for these Protozoa, and considered that the small simple or chambered Foraminifera of free habit were derived from some group of sedentary encrusting forms represented perhaps in the fossil state by the Stromatoporidæ.

At the conclusion of the address **Mr. Earland** commented on the subject of Professor Hickson's work, pointing out that until his exhaustive paper on Polytrema was published, very few people could have seen Carter's species, which he had, quite justly, separated from the old Polytrema, and for which he had created a new genus Sporadotrema. As far as his own experience went Sporadotrema was of very local distribution and rare, but Professor Hickson had utilized every opportunity while working out Professor Gardiner's Indian Ocean collections, in which Sporadotrema was not rare.

He did not doubt that in regard to the separation of Homotrema from Polytrema they were on the right track; but in regard to the rhizopodal nature of Sporadotrema he felt quite unable to follow Professor Hickson. The branching of the tubules in Sporadotrema was a feature quite unique as compared with the tubules of the other Foraminifera, and, in his opinion, would of itself be sufficient to remove the organism to a different Order. The constrictions in the tubuli above the branchings was another distinctive feature, and one which, he thought, pointed to an affinity with the extraordinary organism described by Dakin as *Ramulina herdmani*, in which each tubule was lined with a chitinous membrane, which itself was closed by a diaphragm. He hoped that Professor Hickson would be able to devote some attention to *R. herdmani*, and would be able to agree with the speaker on that point. Of course further research might necessitate the removal of both Polytrema and Homotrema as well as Sporadotrema from the Order Foraminifera, and they would regret that, as they were both beautiful forms. But, as Professor Hickson had told them, the group started their scientific existence as corals, and since then they had figured in other Orders before finding their present resting-place in the Foraminifera, so it would be no novelty for them if they had to travel again. He would like to know whether Professor Hickson, when he was working in the tropics, had an opportunity of seeing Sporadotrema in the living condition. [Professor Hickson: No.] He feared nobody had, and the study of the living organism might entirely revolutionize their ideas of its affinities.

With regard to some of the other points raised by Professor Hickson, he must say that he admired his courage in venturing to revive the theory that the Foraminifera originated with Eozoon or another similar form. The whole of geological evidence was against an original spreading or reef-building form. The oldest geological records of Foraminifera consisted of small single-chambered or primitive rotaline types. He did not quite follow whether the primal form which Professor Hickson postulated was to be an organism of large size or a spreading mass formed by colonies of small individuals; but it appeared to him that if they were going to start with a large organism, it would not have developed by evolution into the microscopic many-chambered forms which subsequently came into existence, but would have continued its evolution on a scale of size something akin to its origin.

The magnificent specimen of *Gypsina* exhibited was quite a surprise to him, although he was acquainted with Miss M. Lindsey's paper, in which these large specimens were described. At the same time he could not agree with her revival of Carter's species *plana.* The common *Gypsina inhærens*, of which a slide had been shown, was a microscopic form, but it had a tendency to grow in all directions, and there seemed no reason why it should stop at any particular size. On small stones and shells one could see twenty or thirty individuals growing close together; they gradually impinged on each other, the stronger individual becoming superimposed on to the weaker and entirely investing the original host. The enormous size of the specimen exhibited was, in his opinion, merely the result of a great number of years of growth. Nothing whatever was known about the age to which Foraminifera lived, except in the case of a few small forms which had been kept under observation. He did not doubt that some of the bigger forms, which lived in deeper water, might have a very long life, perhaps twenty or thirty years or more. A specimen like the *Gypsina* shown might have been growing for a great many years, and still be alive on the surface layer of chambers, though the inside would be dead. There was no connexion between the surface layer of the numerous individuals and the inner layers on which they grew.

He would not like his remarks to be regarded as having been offered in any hypercritical sense. It was his privilege to propose a motion which he was sure all who had had the treat of listening to Professor Hickson's paper would agree with—their cordial thanks for what had been one of the most interesting and suggestive, if perhaps debatable, papers which had ever been given in that room. He only wished the Professor lived nearer to him, for he was sure that enough had been said on this occasion to keep them in discussion for another year.

After Professor Hickson had replied **Mr. E. J. Sheppard** exhibited a slide of the anther of *Lilium candidum* showing pollen mother-cells, in which he demonstrated the extrusion of nuclear material or chromatin from one cell into another adjacent cell, which seemed to take place during the synaptic stage, in the first mitosis. When the chromatin was proceeding from one cell into another it appeared that the cytoplasm in front of it was either absorbed or liquefied. So far no fusion of the chromatin with that of the "receptor" cell had been observed. Occurring in Primula, the phenomenon was brought to his notice by Miss Mitchell when the Biological Section of the Society visited the John Innes Horticultural Institution, and reference to his collection brought to light the same appearances in a seven-years' old slide of *Lilium auratum.* The suggestion that the appearances were due to some morbid state produced by the action of a fungus did not seem to be warranted by the otherwise normal condition of the specimen; nor could he accept the suggestion of artefact.

The vote was carried by acclamation.

The following Specimens were exhibited :—

Mr. A. Bacot :—Yellow Fever Mosquito (*Stegomyia fasciata*).

1. Eggs in tubes of distilled water with and without the addition of bacteria or yeast.
2. Section through the ovaries.
3. ,, ,, the egg.
4. Newly-hatched larva.
5. Young larva feeding on stained bacteria.
6. Larvæ and pupæ.
7. Male and female adult specimens.

Professor Hickson :—

1. *Gypsina plana*. A very large specimen from the Indian Ocean.
2. *Homotrema rubrum*. Surface view showing the areolæ.
3. Polytrema. Surface view showing the pillar pores and the smaller foramina.
4. *Sporadotrema cylindricum*. Section through the base of a specimen to show the initial chambers and the foramina.

Mr. E. J. Sheppard :—Extrusion of nuclear material from one cell into another in pollen mother-cell of *Lilium candidum*.

New Fellow :—The following Candidate was elected an *Ordinary* Fellow of the Society : Alfred McEwen.

The President proposed a cordial vote of thanks to Mr. Angus for the Microscopes which he had kindly lent for the evening's exhibits : and joined in that vote the names of Mr. Barnard, who had brought his own lantern, to the obvious advantage of the Society, and Mr. Offord, who had operated the lantern for Professor Hickson's contribution. The vote was accorded by acclamation.

It was announced that the next Meeting would be held on January 17, at 8 o'clock.

AN ORDINARY MEETING

OF THE SOCIETY WAS HELD AT 20 HANOVER SQUARE, W., ON WEDNESDAY, JANUARY 17TH, 1917, MR. E. HERON-ALLEN, F.L.S., F.Z.S., ETC., PRESIDENT, IN THE CHAIR.

The Minutes of the preceding Meeting, having been circulated, were taken as read, approved, and signed.

The President nominated Dr. Leeson and Mr. E. J. Sheppard as Scrutineers for the ballot.

On the proposition of **Mr. Sheppard**, Mr. Grundy was elected Auditor.

The President said the Society had to acknowledge, with grateful thanks, a large collection of works on the Rotifera, Tardigrada, etc. Mr. Rousselet presented to the Society, a short time ago, one of the finest collections on this subject which had ever been brought together, and he was sure it would be the wish of Fellows that their cordial thanks should be returned to him for his handsome donation.

Mr. E. J. Sheppard exhibited a slide under his Microscope showing mitosis in *Fritillaria*, to illustrate a fact recorded by Chamberlain in his recent book, and perhaps to stimulate investigations to determine at what time mitosis was most prolific. In the onion, according to Chamberlain, mitosis was at its maximum between 12 noon and 1 p.m., and at about 11 p.m. The speaker had found those hours were not uniformly true. Still, in the slide of *Fritillaria imperialis*, taken at 12 midday, it was most perfectly illustrated in the root tips. It would be seen that practically every nucleus was in some stage of mitotic division, from the earliest prophase stage to the late telophase stage. The specimen was stained in safranin and iodine-green.

The Hon. Secretary read the Report of the Council for the year 1916 as follows:—

FELLOWS.

The number of Ordinary Fellows elected and reinstated during the year was 14, while 12 died, 1 resigned, and 3 have been removed. One Honorary Fellow has been lost by death, namely, Dr. J. W. Judd, of Kew.

The List of Fellows now stands as follows: 396 Ordinary, 1 Corresponding, 29 Honorary, and 81 Ex-officio, or 507 in all.

REVENUE ACCOUNT FOR THE YEAR ENDING 30TH DECEMBER, 1916.

Dr.	£	s.	d.	Cr.	£	s.	d.
To Journal	574	19	7	By Subscriptions	628	6	0
,, Rent and Insurance	165	4	0	,, Admission Fees	27	6	0
,, Salaries and Reporting	128	12	5	,, Sales of Journal	223	4	7
,, Sundry Expenses, including Postages	29	16	11	,, ,, of Sundries	13	12	2
,, Library, Books, Papers and Stationery	49	3	8	,, Interest on Investments	94	11	9
,, Refreshments at Meetings	5	15	0	,, Advertisements	30	9	1
,, Balance	63	18	0				
	£1017	9	7		£1017	9	7

BALANCE SHEET, 1916.

Dr.

Liabilities.	£	s.	d.	£	s.	d.
To Capital Funds Account				2127	17	4
,, Show Case Fund				12	15	9
,, Sundry Creditors				151	4	9
,, Reserve Account as at Dec. 31, 1915	£349	17	5			
Less Depreciation on Investments	200	0	0			
	149	17	5			
Add Balance from Revenue Account	63	18	0			
				213	15	5
				£2505	13	3

Cr.

Assets.	£	s.	d.	£	s.	d.
By Cash at the Bank	32	9	10			
,, ,, in Hand	3	14	5			
,, ,, on Deposit	200	0	0			
				236	4	3
,, Investments as per last Balance Sheet—						
£400 North British Railway 3 % Deb.						
£500 Nottingham Corporation 3 %						
£400 New South Wales $3\frac{1}{2}$ %						
£915 India 3 %						
£150 Metropolitan Water Board 3 %						
£400 War Loan $4\frac{1}{2}$ %	2181	14	0			
Less Depreciation	200	0	0			
				1981	14	0
,, Stock of Screw Gauges				25	3	0
,, Sundry Properties, Office and Library Furniture				88	2	0
,, ,, Debtors				174	10	0
				£2505	13	3

We have examined the foregoing Account, and compared the same with the Vouchers in the possession of the Society. We have verified the Securities as above mentioned, and find the same correct.

CHAS. D. SOAR, } *Auditors.*
JAMES GRUNDY, }

CYRIL F. HILL, *Hon. Treasurer.*

FINANCE.

The Revenue Account shows a balance of income over expenditure of £63 18*s*.

Compared with last year, the income of the Society shows a further decrease, the revenue from both Subscriptions and Journal sales being lower than for some years past, while the expenditure has been increased by some £83.

The value of the Society's Securities has again very heavily depreciated, and they have been written down by a further £200. The Investment Account now stands at £1981 14*s*.

The Capital Account has been left at the same figure as in the last Balance Sheet, and the depreciation in Investments has been charged to the Reserve Account, which, with the balance from the Revenue Account, now stands at £213 15*s*. 5*d*.

The Council again urges upon the Fellows the necessity of paying their annual dues promptly. The financial year commenced on January 1, 1917, and subscriptions are due in advance.

JOURNAL.

In the Transactions are recorded seventeen original communications.

The Summary of Current Researches relating to Zoology, Botany, and Microscopy, has been maintained as far as has been practicable under the circumstances brought about by the War.

The Council takes this opportunity of thanking the Editorial Staff for its work during the past year.

LIBRARY.

The condition of the Library continues to improve, and greater advantage has been taken during the past year by the Fellows of their privilege in regard to borrowing books from it.

A noteworthy addition to the Library consists of a comprehensive collection of papers on Rotifera, arranged and presented by the late Curator of Instruments, Mr. Charles Rousselet, who has also donated a complete set of his contributions to the study of this subject.

The Society continues to subscribe to Lewis's Circulating Scientific Library, and the Council is glad to note that increasing use is being made of the volumes thus introduced into the Library.

INSTRUMENTS AND APPARATUS.

The instruments and apparatus are in excellent condition, and during 1916 the following donations were received :—

A Wilson Screw-barrel Microscope .	Presented by Dr. H. J. Johnson, through Dr. Hebb.
Two Microscopes of the Ellis Aquatic type.	From Mr. C. E. Heath.
Small French Microscope . .	,, Mrs. Owen.

¼-in. Objective, by Wheeler .	. From	Mrs. Owen.
Sliding Stage, by Mr. Rousselet .	,,	Mr. Rousselet.
Stage-vice, by Ross . . .	,,	Mr. Rousselet.
Artificial Daylight Disk . .	,,	The Corning Glass Co.
Mount to the latter . . .	,,	Mr. Curties.

CABINET.

The Council have under consideration the re-organization of the Collection, with a view to making the slides more accessible to Fellows.

MEETINGS.

The Ordinary Meetings have during the past year proved exceptionally successful, as regards the nature of the communications read, the interesting collection of exhibits, and the very high average attendance by Fellows and Visitors.

The Biological Section, now under the Secretaryship of Mr. Wilson, has held eight meetings, and the good attendance has been maintained.

Mr. Robotham proposed the adoption of the Council's Report.
Mr. Hiscott seconded, and it was carried.

The Scrutineers having handed in their report,

The President announced that the Society had approved the list of suggested Officers of the Society, as printed :—

President.—Edward Heron-Allen, F.L.S. F.Z.S., etc.

Vice-Presidents.—Joseph E. Barnard ; Arthur Earland ; R. G. Hebb, M.A. M.D. F.R.C.P. ; F. Shillington Scales, M.A. M.D., etc.

Treasurer.—Cyril F. Hill.

Secretaries.—John W. H. Eyre, M.D. F.R.S. Edin. ; David J. Scourfield, F.Z.S.

Ordinary Members of Council.—H. F. Angus ; Alfred N. Disney, M.A. B.Sc. ; F. Martin Duncan, F.R.P.S. ; T. H. Hiscott ; J. Milton Offord ; Robert Paulson, F.L.S. ; Percy E. Radley ; A. W. Sheppard ; Edward J. Sheppard ; Charles Singer, M.A. M.D. ; Charles D. Soar, F.L.S. ; Joseph Wilson.

Editor of Journal.—R. G. Hebb, M.A. M.D. F.R.C.P.

Librarian.—Percy E. Radley.

Curator of Instruments.—Charles Singer, M.A. M.D.

Curator of Slides.—Edward J. Sheppard.

The President then delivered his Presidential Address, entitled "Alcide d'Orbigny, his Life and his Work," at the close of which,

Dr. A. Smith Woodward said it gave him much pleasure to propose a vote of thanks to the President for his address, and to request his permission for its publication in the Journal. He often thought, when occupied with scientific work, that they forgot too much the debt they owed to some of the early pioneers, whose publications they scarcely felt it necessary, under ordinary circumstances, to read. There were many old works, such as those to which the President had referred, which there was no longer any need to consult, apart from questions of nomenclature; but among such early studies they often found most remarkable discussions of questions which struck pioneers as difficult, though they were now, perhaps, comparatively understood. In these days of increasing technicality, it added to the interest of scientific writings if they treated their subject in a more or less historical manner, with some reference to the beginnings of the various ideas dealt with. The President, in his most exhaustive address, had provided the Society with an admirable example of the way in which pioneers should be regarded. The speaker had had the privilege, thanks to the President, of reading the whole of the address, and one of the features it brought out was the immense industry of d'Orbigny—a feature which was noticeable in the work of most pioneers; the amount of research that they were able to accomplish was astonishing, considering the disadvantageous conditions of the time, and in d'Orbigny's case considering the added difficulties of his relations to his contemporaries to which the President had referred. Another point of interest in the work of d'Orbigny was his effort to discover the meaning of the facts he observed and recorded. D'Orbigny thought he understood their meaning, and the whole of his researches in his later life were directed towards discovering the truth, or otherwise, of the conclusions to which he had arrived. Some of the theories of d'Orbigny, the speaker thought, were not completely discarded even now: but even if they were no longer generally held, they certainly enabled d'Orbigny to piece together his work in a way which would otherwise have been impossible. At any rate, he inaugurated methods which they, with their increased information, could only adopt with profit. It therefore gave him much pleasure to propose the resolution he had mentioned.

Mr. A. W. Sheppard said he had much pleasure in seconding Dr. Smith Woodward's proposal.

Professor W. W. Watts said he was not a student of Foraminifera, but he felt as a geologist that they owed a great deal to men like d'Orbigny, many of whose terms were in use to this day. It was to be hoped that his method of nomenclature would always influence geology; and although d'Orbigny might have been wrong in many of his notions, he drew strong attention to facts, and the man who did that often accomplished a great deal of good, even if his notions were not quite correct. For example, the mere fact that a man held the view that there had been on the earth twenty-six cataclysms was the cause of his marshalling all the evidence he could in favour of it, and that compelled his opponents to bring all the facts they could to bear against it, with the inevitable result of the world in general getting nearer to the truth. He had listened with great interest to the address, and the Society was deeply indebted to the President for the trouble he had taken on the matter.

The President said the pleasant task devolved upon him of proposing a vote of thanks to the Honorary Officers of the Society. Many of those present had served on the Council of the Society, and therefore knew the immense amount of work to be done by the Honorary Officers, and knowing the willingness and skill with which those duties were performed, he felt sure the Meeting would join with him in adopting the resolution.

The motion was carried.

The President announced that the next Meeting of the Society would be held on February 21, at 8 o'clock, and the next Meeting of the Biological Section on February 7, at 7 o'clock, when Mr. A. W. Sheppard would give a résumé of Dr. Leiper's researches on endemic *Hæmaturia* in Egypt.

New Fellows :—The following were elected *Ordinary* Fellows of the Society: Walter Clemence, William Fotheringham, Leonard Newton Hensman.

The following Specimens, Books, and Photographs were Exhibited.

By the President :—

Alcide d'Orbigny. From a lithograph by E. Lavallée, 1839.

Ditto. From a daguerreotype of 1843, in the Musée de Paléontologie, Paris.

The Home of the d'Orbignys at Esnandes, near La Rochelle. By J. A. Lovegrove, after L. Musset.

The early Microscope used by d'Orbigny (?). Preserved in the Musée Fleuriau de Bellevue, at La Rochelle.

The later Microscope used by d'Orbigny, in the possession of Madame Henri d'Orbigny.

A few of d'Orbigny's original Models of Foraminifera, from the first Instalment of 1823.

Some d'Orbignyan species of Foraminifera.

One of d'Orbigny's original mounts of Foraminifera, *Siderolina calcitrapoides* Lamarck. (= *Calcarina spengleri* Gümbel.).

Haplophragmium humboldti Reuss, from Chatelaillon.

Nonionina depressula (W. & J.), constituting 99·9 p.c. of the Foraminifera of Esnandes.

Facsimile of the "Planche Inédite" of *Rotalia*.

Ditto ditto of *Rosalina*.

Group of Foraminifera from the mud-flats at Esnandes, near La Rochelle.

Group of Foraminifera from the shore-sands at Chatelaillon, near La Rochelle.

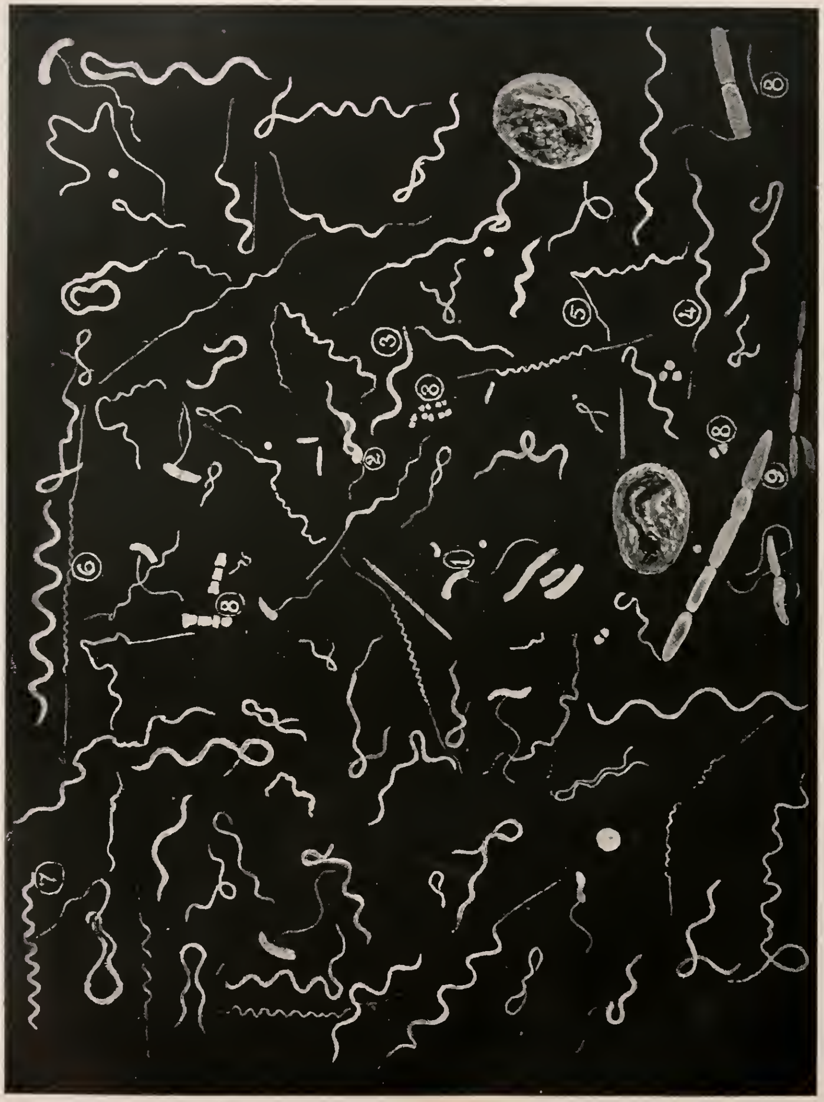
The Mussel Fishery at Esnandes, near La Rochelle.

A. Batsch, "Sechs Kupfer Tafeln mit Conchylien des Seesandes." Jena, 1791. Latin and German editions. (There are only two copies of the Latin edition known.)

Vol. I. of Soldani's "Testaceographia et Zoophytographia," 1789.

By Mr. E. J. Sheppard :—

Mitosis in *Fritillaria* root-tip; fixed at 12 noon.



JOURNAL

OF THE

ROYAL MICROSCOPICAL SOCIETY.

APRIL, 1917.

TRANSACTIONS OF THE SOCIETY.

II.—*The Parasitology of Pyorrhœa alveolaris.*

By Aubrey H. Drew, D.Sc.,

Bacteriologist to the Royal Institute of Public Health and Lecturer on Bacteriology, Royal Dental Hospital, London,

AND

Una D. Griffin, M.B.,

Assistant Bacteriologist, Guy's Hospital.

(*Read February* 21, 1917.)

Plates XIV to XVII and 1 Text-Fig.

The investigations forming the subject-matter of this paper were carried out in the Bacteriological Laboratories of the Royal Dental Hospital and the Royal Institute of Public Health. The work was originally commenced in collaboration with Dr. W. J. Penfold, of the Lister Institute, and it was our intention to ultimately publish a joint paper. Owing to Dr. Penfold having left this country for Australia he was unable to continue the work, and it

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EXPLANATION OF PLATE XIV.

A typical dark-ground preparation from a bad case of pyorrhœa.

Fig. 1.—New species of flagellate.
,, 2.—Trypanosome-like form.
,, 3.—*Spirochæta buccalis.*
,, 4.—*Treponema vincenti* (*Spirochæta vincenti*).
,, 5.—*T. macrodentium.*
,, 6.—*T. microdentium.*
,, 7.—*Spirochæta refringens.*
,, 8.—Various bacteria.
,, 9.—Leptothrix filaments, coarse and slender.

was deemed advisable by us to publish the paper as it stands in the light of a preliminary communication.

The parasitic amœba of the mouth was originally described by Gros in 1849, and since that time many observers have considered it to be the chief causal agent in pyorrhœa. Bass and Johns, for instance, in their recent work (*1*)* consider that the *Entamœba buccalis* is the causative organism in pyorrhœa, and that destruction of the amœba by means of emetine is the cure of the condition. It therefore seemed desirable to make use of the very large amount of material passing through our hands at the Dental Hospital to endeavour to settle the questions (1) whether amœbæ are invariably associated with pyorrhœa; (2) whether more than one species of amœba exists under such conditions; (3) the possible pathogenicity of such amœbæ; and (4) the possible relationship of other organisms to the condition.

Technique.

Examination of material taken by means of the technique described by the majority of authors gave very inconsistent and disappointing results, and it was clear that to study these questions properly a better method of obtaining material from the patients was necessary.

The method finally adopted, and by means of which the whole of this work has been carried out, is as follows:—

A glass tube is drawn out in the flame so as to form a Pasteur pipette about 6–8 cm. in length. The fine extremity is then softened in the flame and quickly drawn out to capillary thickness. This is cut off about 1 cm. from the end, and then turned up at a right angle so as to form a pipette of the shape shown in fig. 1. A little 0·5 p.c. saline is allowed to run into the fine extremity by introducing the point of the pipette into a test tube containing the fluid, and the pipette is ready for taking the material. The patient's mouth is examined, and a suitable pocket is selected, and the capillary portion of the pipette is then introduced into the pocket and pushed up to the top of the floor, and then gently drawn along, and finally withdrawn. The material contained in the pocket enters the pipette by capillarity, and mixes with the saline. For routine examination, the contents of the pipette are blown out on to a glass slide, and mixed by drawing up into the pipette and blowing out again, two or three times. A few drops of the resulting emulsion are placed on a slide, a cover-glass is applied, and at once sealed by running melted paraffin-wax round the edges. The preparation is then examined with the

* The figures in brackets refer to the Bibliography at the end of the paper.

Microscope, and the presence or absence of amœbæ and other organisms recorded. At the same time as the observation preparation is made, a drop or two of the emulsion is spread out on a perfectly clean cover-glass, which is at once dropped, film-side downwards, into Schaudinn's fluid. After fixation, the preparation is passed through 30, 50, 70 and 80 p.c. alcohol to absolute alcohol, half an hour in each strength being best. From absolute alcohol the preparation is now passed back through the various grades of alcohol (half an hour in each) to distilled water. It is next placed in 2 p.c. iron-alum solution over night. Next day it is placed in 1 p.c. hæmatoxylin for twenty-four hours, and is then differentiated by immersing in 2 p.c. iron-alum, the decolorization being watched by means of the Microscope till the nuclei are sharply differentiated. The preparation is washed, and passed through the ascending grades of alcohol (fifteen minutes in each), and then cleared with xylol and mounted in balsam. Staining

Fig. 1.—Glass capillary pipette used for collecting material from pyorrhœal pockets. × two-thirds.

by means of Giemsa, after wet fixation with methyl-alcohol, was tried in a number of cases, but invariably proved less satisfactory, and it should be clearly understood that to obtain reliable results the iron-hæmatoxylin method, tedious though it be, must be used, although very pretty pictures are often obtained with the Giemsa method.

Working in this manner, some 300 cases have been systematically examined, and the presence of amœbæ has been demonstrated in every one. Twenty normal mouths were also examined, and in every case, provided there was no trace of gingivitis, no amœbæ could be demonstrated.

In every case of pyorrhœa examined, the same type of microscopic picture was found. Amœbæ were present in either large or small numbers, and the number of amœbæ found bore no relation to the severity of the disease, neither could the presence or absence of tartar be taken as any criterion as to whether amœbæ would be found or not. In many cases examined no traces of tartar formation could be demonstrated, yet amœbæ were always to be found, if properly looked for, in both the periodontal membrane and deep parts of the pockets.

In fact, the case from which we obtained the greatest number of amœbæ was one of the mildest cases seen. Besides amœbæ, Trichomonas was found in 10 p.c. of the cases. In cases showing Trichomonas, primary examination frequently failed to detect them, and it was noted that if the paraffin-sealed slide was allowed to stand for several hours, and then examined, that the Trichomonas could frequently be found attached to the masses of Leptothrix filaments from the centre of which they had emerged.

General Microscopic Picture in Pyorrhœa (Pl. XIV.).

The picture obtained by microscopic examination of pyorrhœa material is almost invariably the same, and may be summarized as follows:—

Amœbæ are found in larger or smaller numbers, and these bear no relation to the severity of the case.

Trichomonas has been noted in about 10 p.c. of the cases, these cases being usually the more advanced. Leptothrix is invariably present, forming tangled masses frequently containing amœbæ in their midst.

Perhaps the most striking feature, however, in such cases is the immense number of Spirochætes and Treponemata present, at least six species being found, viz.: *Spirochæta buccalis*, *S. vincenti*, *S. refringens*, *Treponema macrodentium*, *T. microdentium* and *T. mucosum*. It should be noted that our definition of the term spirochæte is an elongated sinuous organism, possessing no flagella, but provided with an undulating membrane which may be quite rudimentary. The term treponema we have reserved for similar forms which do not possess an undulating membrane, but which are provided with terminal flagella. We are in agreement with J. G. and D. Thompson (*4*) that *S. buccalis* can readily be distinguished from *S. vincenti*, especially if films are prepared by Benian's Congo-red method. With such films the *S. buccalis* shows distinct traces of an undulating membrane, and never in any circumstances possesses flagella. *S. vincenti*, on the other hand, is invariably thinner, and the coils are very much more irregular, probably owing to the greater flexibility of the body. The *S. buccalis* appears to be very uniform in size, and the coils are extremely regular. The *S. vincenti*, however, often shows great irregularity, and may show all kinds of looping and incurvation. In addition to these differences we find that in properly made preparations the *S. vincenti* shows two fine terminal flagella and should, therefore, be classified as a treponema. It has been stated that it is impossible to distinguish the *S. buccalis* from the *S. refringens*, but we do not think this should be difficult. In our experience we find in carefully prepared specimens that the *S. buccalis* shows blunter ends than does the *S. refringens*. Moreover, *buccalis* shows two to three curves only, whilst the *S. refringens* shows as many as five to seven curves, which are generally very graceful, and has pointed extremities.

With regard to the treponemata found in these cases, the *micro-* and *macrodentium* are easily distinguishable. Both these forms are long delicate treponemata showing long terminal flagella. The depth of the coils and the width of the body, however, are very different in the two species. The *T. microdentium* usually measures 15–20 μ, and the coils are very steep and regular. The *T. macrodentium*, on the other hand, measure 10–15 μ, but the coils are far wider and very much shallower.

We have observed both transverse and longitudinal fission in *all these varieties of spirochætes*, and entirely agree with Fantham that looped forms can be distinguished from those forms undergoing longitudinal fission. In many of these spirochætes, we have observed what has been termed by Fantham "multiple transverse fission." In such cases rounded granules resembling cocci are formed within the body of the spirochæte, the periplast finally rupturing and discharging them into the medium.

In addition to these forms, we have noticed the presence of two flagellate organisms, which we have been unable to find hitherto described, and which we believe to be new species. The first of these forms bears a very striking resemblance to the trypanosomes, and also would appear to have affinities with the spirochætes. This is an important point, as it lends some support to Schaudinn's view that certain spirochætes had a trypanosome-like phase. This form occurs in scanty numbers in the pockets, and indeed we have been quite unable to find it in certain pockets examined. It apparently occurs in three different forms, which may for convenience be described as long, intermediate, and stumpy. The typical form (Pl. XV, fig. 1) has a long sinuous body, provided with an undulating membrane. The anterior end is broad, and ends with a long flagellum, the posterior end thins off to a short point. The average breadth of body in this form is about 1·5 to 1·8 μ, whilst the length in the longer forms may measure fully 15 μ. Division appears to be by longitudinal fission, but as quite small short forms may also be seen, we think that there is probably a second mode of reproduction, which we have not yet been able to determine.

The second form which we have observed appears to be present in the majority of cases of pyorrhœa, but in very varying numbers. Its form is somewhat sickle-shaped (Pl. XV, fig. 2), and it is provided with a single lateral flagellum, and which appears to be connected to, what we take to be, a rudimentary undulating membrane. Its motion is extremely rapid, and it executes many darts and twists, occasionally spinning round with intense rapidity like a top. We have observed all stages of transverse division in this form, which takes place as follows :—

A. Division of the flagellum takes place at the end attached to the body, and gradually spreads to the distal end. The two flagella now travel to opposite poles, and apparently some sort of division of the chromatin also occurs, as two polar caps of chromatin can be observed at this stage.

B. Division of the body of the flagellate next takes place by transverse fission, and the two forms go free. On account of the single laterally placed flagellum, the mode of division, and the movements in general, we consider this form to belong to the group of flagellates rather than to the bacteria. It is not intended to devote more space in the present paper to the spirochætes, as the work is still being proceeded with, and it is our intention to publish a separate paper dealing more fully with these organisms at a somewhat later date.

Bacteria are invariably present in pyorrhœa, often in immense numbers.

Streptococci are found in every case. Fusiform bacilli and vibrios are often extremely numerous. Many cocci are present, including such forms as *Micrococcus catarrhalis*, *Staphylococcus albus* and *S. aureus* and *M. tetragenus*, and others which have not been identified. In the paraffined preparations already alluded to, spirochætes remain actively motile for two or three days. Red corpuscles and leucocytes occur in varying numbers; and in early cases, and in cases showing no macroscopic evidence of pyorrhœa beyond a marginal gingivitis, the presence of microscopic pus was invariably found. In nearly every case immense numbers of leptothrix filaments are present.

Amœbæ.

The invariable presence of amœbæ has already been noted, and these appear to belong to at least two distinct species. The largest form met with measures from 10 μ to 30 μ in diameter. It

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EXPLANATION OF PLATE XV.

Fig. 1.—Various forms resembling Trypanosomes (Congo-red film). (The arrangement is arbitrary, representing what was thought to be the probable sequence in development.)

„ 2.—The new species of Flagellate, showing the usual method of reproduction. (Congo-red film.)

Fig. 1.

Fig. 2.

[Face p. 190.

varies greatly in motility, some forms being very actively motile, whilst others are comparatively sluggish. It possesses a very distinct ectoplasm, the endoplasm being very granular and showing many food vacuoles, which may contain bacteria, red corpuscles, nuclei of leucocytes, and other material. The nucleus is usually invisible in the living organism, and the form contains no contractile vacuole. This amœba when stained by the iron-hæmatoxylin method shows a well-defined ring-shaped nucleus with chromatin distributed at the periphery, and a small central karyosome (Pl. XVI, fig. 1). Chromatin blocks are also occasionally present. Frequently in stained preparations, the amœbæ are so full of red cells as to obscure the nucleus. That the majority of these bodies are red cells is proved by the fact that examination in the living condition often shows many quite fresh normal red cells within the cytoplasm, and these on staining by Geimsa, stain in a perfectly normal manner quite differently from the nuclei of leucocytes which the amœbæ also ingest. There can be no doubt that this amœbæ corresponds to the *Amœba buccalis*, described by Steinberg in 1862, and more fully examined by Prowazek in 1904, and named by him *Entamœba buccalis*. This is, however, undoubtedly the same organism as that described in 1849 by Gros, and named *Amœba gingivalis*, and the name *Entamœba gingivalis* should therefore be used. The smaller amœba found is remarkably uniform in size, measuring on the average from 15 μ to 20 μ. It is usually actively motile, throwing out blunt lobose pseudopodia in all directions, but occasionally it may be quite sluggish. The nucleus in the living condition, as obtained direct from the mouth, is generally invisible; but if some material containing these amœbæ is placed on a cover-glass, and this is inverted on a plain 2 p.c. agar jelly containing polychrome methylene-blue, the nucleus stains a faint purplish blue. The nucleus of *Entamœba gingivalis* treated in the same manner does not stain. Iron-hæmatoxylin preparations show the nucleus to correspond with the free living Vahlkampfia type of amœba (Pl. XVI, fig. 2), viz. a big central karyosome, containing the whole of the chromatin. The amœba shows food vacuoles containing bacteria, nuclei of leucocytes, and, occasionally, red corpuscles, but no contractile vacuole has ever been observed in preparations direct from the mouth. This type of amœba has been observed with *Entamœba gingivalis* in about 65 p.c. of the cases examined.

From previous work on amœbæ (*2*) we were led to endeavour to cultivate the amœbæ found in pyorrhœa. Three different jellies were originally tried, viz. (1) a plain 2 p.c. agar jelly, (2) ordinary nutrient agar jelly, and (3) a jelly which had already been found to be extremely useful in obtaining bacteria-free growths of amœbæ, and stimulating them to divide rapidly. The jelly has the following composition :—2 p.c. agar jelly, 90 c.cm.;

ordinary nutrient agar, plus 10 in reaction, 10 c.cm.; tyrosin, 0·1 grm.; choline, 0·1 grm. The jellies were melted and poured into sterile Petri dishes, 3 in. in diam., and allowed to set. Material was taken in the manner already described, and was spread out on the surface of the jellies. The plates were then incubated to 37° C. After many failures, it was found that a small amount of growth took place in the tyrosin jelly, the amœbæ ultimately forming cysts. Sub-cultures gave a more vigorous growth, and the strain was able to be maintained. The amœbæ so obtained resembled those found in the pyorrhœal pockets, with the exception that a contractile vacuole was always present. Being dissatisfied with the technique, improvements were tried. 0·1 p.c. of creatine was added to the jelly, and material was spread as before. The plates were then placed in a Bulloch's apparatus, and incubated anaerobically at 37° C. Working in this manner, amœbæ were cultivated from some 65 p.c. of the cases. The anaerobic cultures were very vigorous; the amœbæ showed no contractile vacuoles if examined in 0·5 p.c. saline, and indeed were absolutely indistinguishable from those seen in mouth preparations. Moreover, encystment did not take place, even if the plates were incubated for three weeks. This was a very striking fact, as aerobic cultures invariably encysted in four to five days, and only very scanty growth took place. The cysts in this species measure on the average 10 to 12 μ (Pl. XVI, fig. 3). In young cysts the wall may appear single, but in older forms there is often a characteristic double wall, with wavy irregular outline. The cysts are usually uninucleate, but two and four nuclei have been seen. Having obtained twelve different strains of this amœba, it was considered desirable to endeavour first to obtain cultures which were the progeny of a single cyst, and, secondly, to grow the amœba in pure mixed culture with some definite bacterium. The first object was readily accomplished by the method described by Cropper and Drew (*2*). The second was finally attained by a modification of this method for obtaining pure mixed cultures. Four p.c. HCl was found to injure the cysts, and the method finally used was to grow the material from the mouth anaerobically for a week, when very numerous amœba were found. The plate was then removed from the anaerobic chamber, and allowed to remain in the 37° C. incubator till numerous cysts developed. Two p.c. HCl was then poured on to the plate, and was allowed to act for twenty-four hours. At the end of this time the acid was poured off, and as many of the cysts as could be

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EXPLANATION OF PLATE XVI.

Fig. 1.—*Entamœba gingivalis.* (Iron-hæmatoxylin preparation.)
,, 2.—*Amœba buccalis.* (Iron-hæmatoxylin preparation.)
,, 3.—Cysts of *A. buccalis*, young and old forms. (Iron-hæmatoxylin stain.)

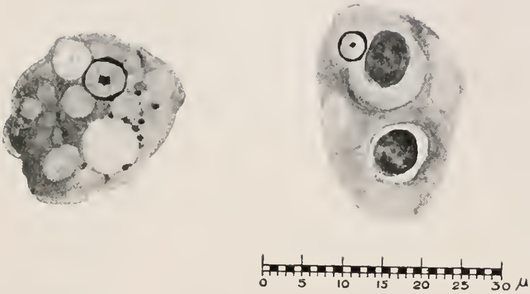

Fig. 1.

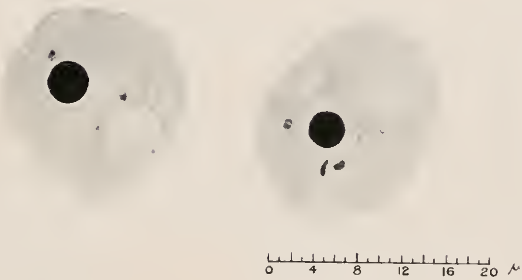

Fig. 2.

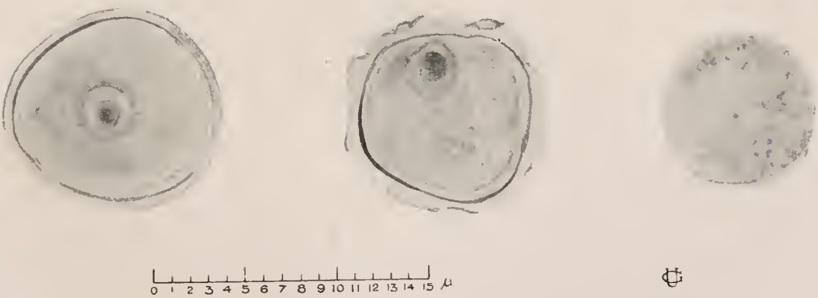

Fig. 3.

[Face p. 192.

scraped off with a platinum loop were removed to a fresh jelly. A loopful of a diluted broth-culture of *Bacillus fluorescens non-liquefaciens* was added, and the plate incubated anaerobically. After four days' incubation the plate was removed from the anaerobic chamber and the amœbæ were allowed to encyst. Hydrochloric acid was again added, and loopfuls of cysts were taken from the edges of the culture and placed on a fresh plate, and *B. fluorescens* added. The plate was incubated anaerobically for a week, and then removed and allowed to encyst. It was then submitted to a bacteriological analysis, and, if found pure, sub-cultures were made on to slopes in test-tubes, which were then incubated in the anaerobic chamber. All strains of this amœba appeared to be identical.

Life-Cycle (Plate XVII).

Having thus obtained pure mixed cultures which were the progeny of single cysts, it was thought desirable to endeavour to work out the life-cycle by continuous observation. The special live-slide devised by one of us (A. H. D.) was used for this purpose. If the cysts be placed on such a slide, and either incubated, or kept on a warm stage, excystation occurs in from three to six or more hours. The cause of excystation has been shown by Cropper and Drew (*2*), Woodcock and Lapage (*3*) to be due to bacterial ferments, and consequently those amœbæ first excysting are found to be those near small masses of bacteria. The first indication of excystation is that one or more minute vacuoles appear in the cytoplasm of the organism, and it retracts somewhat from the cyst wall. Sluggish movement may at this time frequently be observed within the cyst. Finally, the cyst ruptures, appearing to become thinner and thinner usually at one spot, and the contained amœbæ gradually emerges, leaving the empty cyst wall behind. On emerging the amœba appears perfectly normal, and the nucleus well marked. The organism moves away from the empty cyst, but movement is very sluggish. Very shortly it is noticed that the nucleus is becoming very much fainter, and at the same time motion slows down, and the amœba rounds up and becomes quiescent. It remains in this condition for a time, which may vary from thirty minutes to an hour or more. During such time the nucleus appears to undergo change, although of what nature it has proved impossible to ascertain definitely. Two particles or blepharoplasts are given off from the nucleus, and from these gradually arise two minute flagella ; these increase in length till they are two or three times the length of the amœba. As soon as the development of the flagella is complete, the amœba again takes on the ordinary amœboid form and crawls away with the flagella in active motion. The time the organism continues in this state varies very greatly, a fair average being an hour and a half. At length it very rapidly rounds up and takes on an oval form, and then swims off with intense rapidity, the body remaining rigid. This free-swimming phase usually lasts for an hour or so, when it suddenly comes to a standstill, again becomes amœboid, the flagella being cast off, and the form then resembles the amœba as found in the pockets. Multiplication is by binary fission, the nucleus appearing to go through a simple karyokinetic phase. No syngamy has at any time been observed during continuous observation of the species.

Excystation.

It was thought desirable to conduct some experiments with the cysts obtained from these pyorrhœa cases. In the amœba studied by Cropper and Drew, an enzyme which was of a peptic nature was shown to be necessary for excystation, and the amœbæ could be caused to excyst in a weak pepsin-hydrochloric acid mixture. In the present amœba pepsin was never able to cause excystation, and did not appear to have any action on the cyst wall. Horse, human, and rabbit sera were likewise found to be without any definite action on such cysts. Cysts, however, freed from living bacteria, and washed with sterile saline, to remove as many of the accompanying dead bacteria as possible, when placed on the special live slide, were found to excyst with the products formed in broth by the following bacteria: *Bacillus pyocyaneus*, *B. coli*, *B. fluorescens non-liquefaciens*, *Staphylococcus aureus*, *Streptococcus pyogenes*, and *B. tetani*.

The organisms were grown in broth for a week at 37° C. and then filtered through a Chamberland F. filter. Similar results were obtained if the sterile broth products were mixed with the jelly used for growing the amœbæ, the mixing being done at 45° C. to avoid destruction of the enzymes. Bacteria-free cultures were thus obtained, and, if supplied with dead bacteria and fresh serum, could be maintained for some weeks on the special jellies. This particular amœba is fairly tolerant of acid, but very rapidly rounds up and encysts if placed in pepsin-hydrochloric acid, 0·2 p.c. each. It is highly probable, therefore, that the amœba encysts in the stomach.

It will be observed that from a consideration of its life-cycle, and the type of nucleus, that this amœba undoubtedly belongs to

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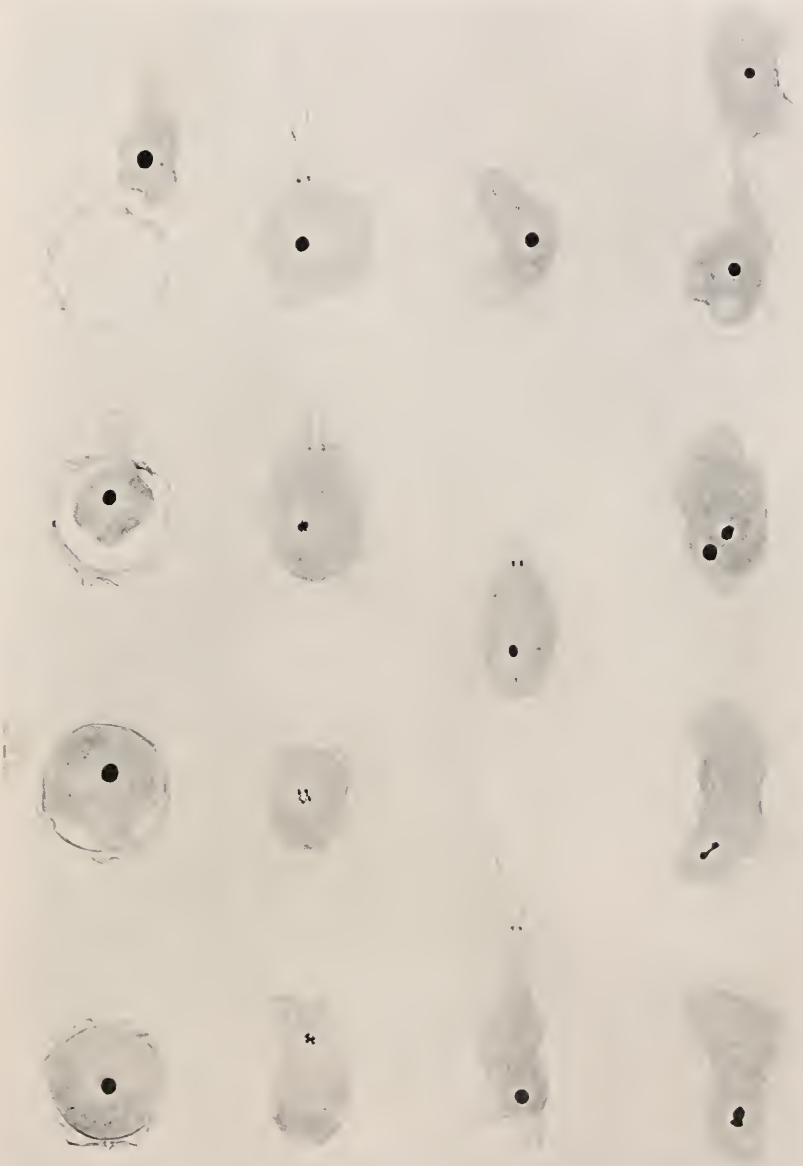
EXPLANATION OF PLATE XVII.

The various stages in the life-cycle of *Amœba buccalis* (semi-diagrammatic).



[Face p. 194.

the so-called Vahlkampfia type, and also appears to have some affinities to paramœba. We would, however, suggest that this particular species may be described as a semi-parasite, that is to say, a free-living form which has become adapted to anaerobic life in the pockets, and has been partly modified thereby.

We consider that this is a reasonable suggestion for the following reasons. As observed in the mouth the amœba corresponds to the parasitic amœbæ in possessing no contractile vacuole. It can grow, and indeed grows best, at a temperature of 37° C. It can develop in strictly anaerobic conditions, under which no free-living form tested would grow well. The entire absence of the contractile vacuole in the amœbæ as seen in the mouth, and its presence in cultures, unless made under strictly anaerobic conditions, is very important. The contractile vacuole in the protozoa has usually been regarded, though without much proof, as an excretory organ, somewhat in the nature of a rudimentary kidney, and these experiments appear to prove this view and to show why the parasitic forms do not possess such an organ. The end product of proteid disintegration and oxidation is usually urea, or bodies allied to it. Now in protozoa, living under aerobic conditions, oxidation may be fairly assumed to produce considerable quantities of such waste products, and hence the need of a special organ for their elimination. In protozoa, living a parasitic life, however, under anaerobic conditions, it is evident that oxidation must be reduced to a minimum, and the need for a contractile vacuole, therefore, does not exist. On no occasion have definite cysts been observed in preparations taken from the mouth, but we have twice seen forms that were either amœbæ in an early stage of encystation, or cysts themselves, but it was exceedingly difficult to feel certain of the point. That encystment, if it occurs at all in the pockets, would be extremely rare is shown by the fact that encystment is very long delayed under strict anaerobiosis, and may not occur at all. We would suggest the name *Amœba buccalis* for this species, the parasitic type being known as *Entamœba gingivalis.*

Having obtained pure cultures, Dr. Penfold suggested that it might be possible to produce a specific lysing serum, either for the cysts or for the amœbæ. He therefore injected a series of rabbits intravenously, and another series subcutaneously, with a strong suspension of cysts killed by heating to 56° C. in normal saline. After two such injections, four more inoculations were made, using suspensions of living cysts. In the case of the rabbits receiving intravenous injections no effect was observed, whilst in those inoculated subcutaneously, swellings were formed which contained a thick pus. This pus was found to contain cysts in the living condition, and cultures were obtained. Samples of the blood were tested from time to time, but no particular lysing action could be observed at any time. A remarkable fact that has recently been brought to light by this research is, that in a large number of pyorrhœa cases examination of concentrates of the fæces, prepared by the method described by Penfold, Woodcock, and Drew (*5*), has shown cysts to be present which bear a very striking resemblance to those described by Elmassian as *Entamœba minuta*, and we have found it quite impossible, up to the present, to cultivate such cysts. This point would appear to be of importance, as mistakes in dysentery diagnosis might occur by confounding such cysts with those of the pathogenic dysentery amœbæ. The cysts observed in these pyorrhœa cases measured from 7–8 μ in diam., and when examined in the free state no definite nucleus could be observed. When, however, Gram's iodine solution was mixed with the fæces, the cysts were found to show two ring-shaped nuclei. We would suggest that these cysts probably represent those of *E. gingivalis*, and we are inclined to think that many of the so-called *minuta* infections are really of this nature.

Having obtained cysts in large quantities, we determined to see whether advanced cases of pyorrhœa showed any complement fixation, using as antigen both alcoholic and saline extracts of the cysts. Blood from twelve cases was taken and treated, but in only one case was there the slightest evidence of any fixation of complement.

It is not our intention to deal with the purely clinical side of pyorrhœa in the present paper, but so far as we have gone in this research the conclusions regarding the causal rôle of the amœbæ in pyorrhœa are that they have little to do with the disease. Mechanical injury seems to play an exceedingly important part in the commencement, which in our experience appears to start almost invariably as a marginal gingivitis. Spirochætes and treponemata are well known to possess the power of boring into the tissues, and many of them, such as the *Spirochæta vincenti*, may cause much tissue destruction, which is well seen in certain cases of Vincent's angina. We think that when once injury has occurred the spirochætes play the chief part in the disease, causing the tissue destruction and formation of pockets. When once pockets have been formed, the pyogenic cocci and other organisms find an exceedingly good breeding ground, where toxin formation and absorption can go on continuously; and, in considering the treatment of the disease, we think this secondary bacterial infection should always be borne in mind. The amœbæ, however, when once established in the pockets would certainly appear to aid the destruction of tissue, and it seems certain that they cause a good deal of destruction amongst the red cells. Lately we have found the use of arsenic preparations, such as atoxyl and salvarsan, of great value, but we think that in all cases vaccine treatment in addition is to be strongly recommended. We have not found emetine to be of the slightest value in treatment, and, although at times the amœbæ may show a decrease in numbers during emetine treatment, in our experience this is rare, and they invariably appear again. Isolation and culture of the spirochætes has not up to the present proved entirely successful, but is being pursued, as is also the endeavour to cultivate the *Entamœba gingivalis.* (So far we have found it impossible to keep this parasite alive for any length of time, although if placed on the special jellies, and incubated anaerobically at 37° C., it will often be found alive at the end of three or four days. Whether any multiplication takes place under such conditions we have not yet settled, although on several occasions we think there was some increase. Ultimately the bacterial growth completely inhibits the amœbæ, and up to the present we have not been able to surmount this difficulty.)

Our very best thanks are due to Dr. H. M. Woodcock, of London University, who throughout has taken great interest in the research, and who has given us very much help in criticizing and making many valuable suggestions.

Bibliography.

1. Bass & John.—Alveodontal Pyorrhœa. Saunders & Co., 1915.
2. Cropper & Drew.—Researches into Induced Cell Reproduction in Amœbæ. London: J. Murray, 1914.
3. Woodcock & Lapage.—Proc. Roy. Soc., Ser. B. lxxxviii. (1915) p. 353.
4. Thomson, J. G. & D.—Proc. Roy. Soc. Med., vii. No. 9.
5. Penfold, Woodcock & Drew—Brit. Med. Journ., May 20, 1916.

NOTE.

Two Letters from Professor Abbe to John Ware Stephenson.

Communicated by F. J. Cheshire.

Two Facsimile Figs.

I send herewith for the pages of the Journal of the Royal Microscopical Society copies of two letters, already of historical interest, relating to the design and production of the first Microscope homogeneous-immersion objective, made with the object, *inter alia*, of testing the possibility of obtaining enhanced resolving power by the use of such an immersion liquid. These letters, which were written by Professor Abbe to the English microscopist, John Ware Stephenson, towards the close of the year 1877, speak for themselves. I am able to bring them to the notice of the Royal Microscopical Society by the courtesy of their present owner. The first of these letters reads as follows:—

Jena, *Nov.* 14, 77.

Dear Sir,

I beg your kind indulgence for the unpolite silence which, till now, I have opposed to your letters. I hope you will pardon me, considering that I am a much occupied man. I wished to give a distinct answer to your question about oil-immersion objectives; and, being prevented from studying the question by want of time, writing has been protracted so long.

Now the matter is, that from a different point of view, some time ago I have considered already the oil-immersion. I had in view the advantages of this arrangement for petrographic work, i.e. the observation of what we call "Dunnschliffe." As those thin plates of minerals, which are used for microscopic inspection, generally are roughly ground and not well polished, their observation with higher powers, even with immersion lenses, has some difficulty, which a fluid of higher refraction would prevent. In this aim I have made a preliminary calculation already in last winter; but I had not time to finish it. Your suggestion now induced me to study this object from a more general point of view, especially to take in consideration the increase of aperture, which this mode of immersion could possibly afford.

Some days ago I have succeeded in the calculation of $\frac{1}{8}''$ on this principle, which, I hope, will prove some advantage compared with the common immersion lenses. I have got a formula for the highest aperture, which, I think, has been realized till now, 112° *balsam*-angle

—the product of refractive index, with the sine of the semi-aperture angle being $= 1 \cdot 25$ (while with the immersion lenses of Zeiss till now this product is $= 1 \cdot 10$). The technical work of such a system will be somewhat difficult, but I hope we will succeed. In a few days the lenses will be ground, and as soon as the thing is finished, I will send it to you and ask your judgment.

There is a difficulty in the combinations with oil-immersion, which will be observed as well in the technical work, i.e. the fabrication, as in the application of such an objective, and which, perhaps, will make illusory this advantage, which you make prominent: the independence of cover-thickness and the dispensing of a correction-setting. The want of a medium of different refraction in front of the system will take away the most effective element for compensating the slight differences of workmanship in the lenses (the unavoidable differences of curvature and thickness) *and the differences in the length of tube.* By want of this compensating element the objective will be most sensible for the least difference in the length of tube; and, I presume, a sort of correction-setting will be necessary in this respect, unless the use of the lens should not be restricted to a tube of exactly defined length. Now the experiment will soon settle this point.

As to the liquid, a mixture of oil of turpentine with oil of cloves will do very well, and it will be very easy to any observer to get the right mixture by observing the disappearance of a piece of cover-glass in the fluid, which is a very sensible proof for equal refractive index. . . .

* * * * * *

Repeating my excuse for the long delay of my answer, I send you my best compliments, and remain

Yours most sincerely,

(Signed) E. Abbe.

The second letter reads as follows:—

Jena, *Decr.* 29, 77.

Dear Sir,

I have the pleasure to give you notice, that the experiment with the oil-immersion objective has been successful. Some accidents in the work and a great pressure of business in Mr. Zeiss' workshop during the last months, have been the cause of a longer delay than I expected. But these difficulties have been overcome, we have got a lens of excellent performance. The aperture taken in my calculation—$1 \cdot 25$ numerical value $= 113°$ balsam-angle—has come out exactly without any lack of definition. The objective will bear extraordinarily deep eye-pieces, and in accordance with the calculated effects will give a very flat field. As I have no great experience in fine diatom work, I did not make many trials of this kind. But the advantage of the great aperture is already visible in a most striking manner on the image of *Pleurosigma angulatum* observed with oblique light. This diatom mounted dry (but with frustules adhering to the cover) will give quite a new aspect, if the oblique pencil of light is directed perpendicular to the axis of the valve (or, more generally expressed, *parallel* to any of the three ordinary sets of lines on it): while rectangular fields, separated by dark broad

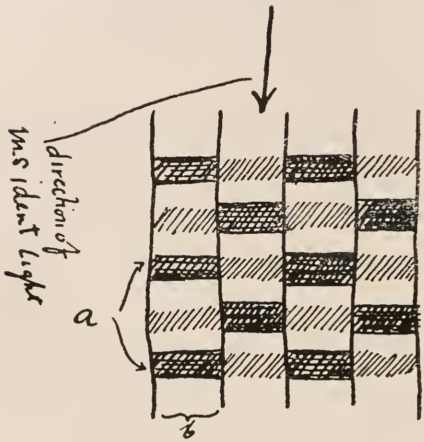


FIG. 2.

beams, alternating from row to row, *and these beams proceeding, as pale shadows, through the white fields of the neighbouring rows.* If b in the figure is the distance of the ordinary lines on *P. angulatum*, the interval a between the consecutive beams is

$$a : b = 2{\cdot}2 : \sqrt{3}$$

This unusual image results from the entering of a new set of diffraction pencils, which by a smaller aperture are shut off. The diffraction spectre of any structure the elements of which are arranged in congruent rows, crossing under angles of 120°, must have the following form:—where the marks ● denote the six spectres next to the image A of

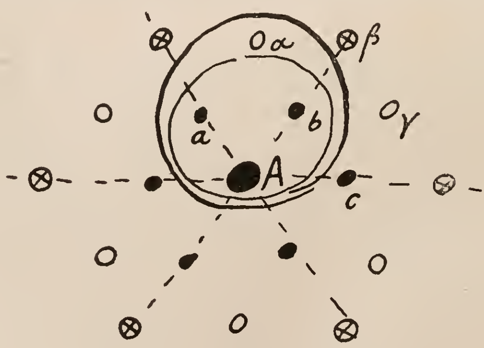


FIG. 3.

the undiffracted pencil, ○ ⊕ the twelve spectres of a more distant circle. Now, in the case of *Pleurosigma* to an aperture of moderate amount the spectra α, β, γ are inaccessible, even with oblique light, or at least so much weakened in their intensity, that no effect will get visible. An aperture of 1·25, on the contrary, admits, with oblique light, *one* of the spectre of the second circle with full intensity : in looking down into the open tube, the *four* pencils A, *a*, *b*, and α are to be seen within the margin of the system. This arrangement of light—four coherent pencils, arranged in a ◇—must give the image spoken of ; and, especially, the coincidence of A and α must bring out a set of lines, parallel to the axis of the valves, the distance of which is to *b* as $1 : \sqrt{3}$. Those lines are to be seen *as continual ones throughout the whole valve,* if the two pencils *a* and *b* are moderated in their brightness, or quite stopped off by a diaphragm above the objective.

The managing of the system is quite easy. The length of tube held invariably there is no cover-correction necessary, indeed. Extremely thin and extremely thick covers give equal definition. There is only one inconvenience, which till now I did not master. I considered as unquestionable that among the great numbers of fluids, which are fit for use, there would be some, pure or mixed, which would give the exact refractive power of crown-glass and an equal dispersion too. But after having measured the refraction and dispersion of more than sixty oils and other fluids during the last weeks, I find that my assumption was premature ; all the fluids, found till now, which have the refractive index of crown (or are brought to this refraction by mixture with another fluid) give a considerably higher dispersion. Therefore the different thickness of the fluid, caused by the difference of cover, must give a slight alteration of the chromatical correction of the lens.

If I should not succeed in finding a liquid of the right quality, the want will not at all be a grave one. In this case I shall adjust the colour-correction for *thin* cover, taking the liquid of minimum difference. For a considerably thicker cover, the correction now will be made perfect by adding to the liquid a small portion of a more dispersive fluid. This will not be a great inconvenience, I think.

In this way I have managed the system till now, taking the *oil of copaiva-balsam* as base of the mixture and adding varying portions of oil of cloves. Using a small bottle with parallel faces (made of plate-glass) and a small prism of crown-glass plunged in, the refraction *and* dispersion of the mixture can be adjusted most exactly by simply viewing the window-bar through the prism and the liquid.

The provisory setting of the new objective would be somewhat troublesome to you, and besides that I cannot dispense with it in my further experiments with new liquids. From these reasons I have not yet sent it to you ; I prefer to keep it until three new samples will be finished, which are in work now. The *best* of the four will be brought to your short setting, and will be sent to you as soon as ready, together with the testing-bottle described above. I hope you will agree with this delay. For petrographic work the oil-immersion will be exceedingly convenient ; but besides that, as the greater aperture will yield a greater resolving power, lenses on this plan will be accepted by yonr English diatomists I think. But they will be much more costly as far as the unusual aperture is wanted—which will not be necessary for petrographic work. The workmanship is exceedingly delicate and difficult, especially as to the front lens. Among the twenty-four opticians in Mr. Z.'s workshop there is only one who can grind a front lens admitting a balsam angle of 113°, and only one who can make the brass-work to it. We were obliged to make several new contrivances for the work before it succeeded.

The sensibility of the system, in point of chromatical correction, for the dispersive power of the immersion-liquids, is an agreeable circumstance in one respect. By the nature of the optical glass, flint and crown, as it is till now, there is, unavoidably, a difference of spherical aberration, for different colours, and, from this cause, a difference of the colour-correction between the central and the marginal parts of a system. Now this difference can be easily regulated by slightly changing the dispersive power of the immersion-liquid ; a smaller dispersive power of this liquid will give the best correction of colour for *oblique* light—a greater dispersion for central light.

In a similar way, slight differences in the length of tube may be perfectly compensated by a different mixture of the fluid.

In two or three weeks, I hope, the new lens will be in your hands ; and I think you will be contented with the result, your impulsion has brought forth.

In the meantime I send you my best wishes for a happy new year, and remain

Yours sincerely,

(Signed) E. Abbe.

The above letters, of course, are of very great interest to microscopists from the historical point of view, but they have in addition, at the present time, a peculiar interest for opticians and optical manufacturers generally, because of the information they give indirectly as to the high state of efficiency which had, even at that time, been reached at Jena in the work of optical designing and computing. We know that at this time Abbe had set himself "to abolish once and for all workshop trial-and-error methods, and to replace the rough approximations to the ray-path by more exact mathematical determinations, which, expressed in cast-iron formulæ, should enable the necessary structural elements of the lenses, such as thicknesses, diameters, radii of curvature, etc., to be exactly determined by calculation simply and alone."

It will be noticed that on November 14, 1877, the calculation for the proposed objective had been completed "some days ago." Six weeks later only, Professor Abbe was able to announce that his mathematically determined results had been realized in a concrete construction with great exactitude. We are told that the experiment with the oil-immersion objective had been successful ; the computed aperture had been exactly realized without any lack of definition. This is a lesson which should be taken to heart at the present time. Many people are under the impression that the designing and computing of first-class optical systems must of necessity be checked by workshop trials. By the methods of design introduced by Abbe the concrete embodiments of a system produced in a workshop do not test the conclusions arrived at by the designer and computor, so much as they serve as means for determining the accuracy with which the mathematical results can be realized in the workshop—i.e. in first-class optical designing the designer tests the work of the workman, the workman does not test the work of the designer.

SUMMARY OF CURRENT RESEARCHES

RELATING TO

ZOOLOGY AND BOTANY

(PRINCIPALLY INVERTEBRATA AND CRYPTOGAMIA),

MICROSCOPY, ETC.*

ZOOLOGY.

VERTEBRATA.

a. Embryology.†

Experimental Embryology.‡—E. W. MacBride calls attention to the definite proof of organ-forming substances in the ovum which has been furnished by the experiments of Crampton, Wilson, Conklin, and others. If the first polar lobe in the developing ovum of *Dentalium* is cut off, the trochophore larva is devoid of the apical plate, the apical tuft, the mesoderm, and the post-trochal region. If the second polar lobe is cut off, the trochophore is devoid of mesoderm and post-trochal region. The segregation of different substances in the Ascidian ovum is the real cause of the differentiation of the germ-layers. Experiment also shows that the condition of the formation of a normal frog embryo is the proper spatial relationship between two organ-forming substances.

Observation and experiment confirm the view that the organ-forming substances emanate from the chromatin of the nucleus. The formation of these substances appears to last for only a short period; after that the nuclei appear to be without formative influence on the cytoplasm. But in animals like Polyzoa and Ascidians which bud, this budding could be best explained as due to a renewed production of organ-forming substances by the nuclei. These substances are often not distributed to the formative tissues of the bud in the same manner as in the embryo, hence the development of the bud often follows a different course from that initiated by the embryo.

* The Society are not intended to be denoted by the editorial "we," and they do not hold themselves responsible for the views of the authors of the papers noted, nor for any claim to novelty or otherwise made by them. The object of this part of the Journal is to present a summary of the papers *as actually published*, and to describe and illustrate Instruments, Apparatus, etc., which are either new or have not been previously described in this country.

† This section includes not only papers relating to Embryology properly so called, but also those dealing with Evolution, Development, Reproduction, and allied subjects.

‡ Nature, xcviii. (1916) pp. 120-3.

Of great importance is the inquiry into the influence which the primary organs exert on each other's further development. Herbst found that if the eye-stalk of a shrimp is amputated, the animal grows a new one; if the optic ganglion be also removed an antenna-like organ is formed. This must be due to the presence or absence of some chemical substances, like hormones. Lewis found that if the optic vesicle of a tadpole's brain was cut off and pushed into a new position beneath the skin, a lens developed from the skin at the new spot. There must be emanations from the optic vesicle. It is possible, as J. T. Cunningham has suggested, that specific hormones or the like may be liberated from modifications of tissue, and may pass to the germ-cells.

Twin-embryos in Duck.*—Edward S. Ruth describes four sets of twin-embryos of the duck. Twins may be divided into (1) dissimilar, (2) identical, and (3) joined twins. The first type results from the fertilization of several ova, or possibly a multinucleate ovum; the second type arises from the separation of early blastomeres or parts of one ovum; the third type includes all those twins that are joined—probably due to an incomplete separation of the early blastomeres, or of the embryo-forming substance at some later stage. The identical and joined twins belong to the same category. In the four sets of duck twins, three sets were joined, while in the remaining one the twins were separate.

Siamese Grafting.†—O. Laurent calls attention to the possibility of making a vital union, which he terms "siamese grafting," between two higher animals. He has succeeded with fowls and with ducks. More remarkable was a junction effected between fowl and pigeon, and another between pheasant and duck. He has applied the idea twice to wounded soldiers, and thinks it may have a future of importance.

Inheritance in Guinea-pigs and Rats.‡—W. E. Castle obtained in Peru a wild species of guinea-pig, the probable ancestor of the domesticated forms, identified as *Cavia cutleri* Bennett. He also procured a feral race from Ica, and domesticated Peruvian guinea-pigs. It can be stated, with probable correctness, that the guinea-pig has undergone, in domestication, more extensive variation in colour and coat characters than any other mammal, and that this variation has occurred almost if not quite exclusively under the tutelage of the natives of Peru. This conclusion points either to a great antiquity of the guinea-pig as a domesticated animal or to more rapid evolution by unit character variation than by other natural processes. It may be noted that the Argentine *C. aperea* has perhaps given origin to some domesticated races, and that when the Brazilian *C. rufescens* is crossed with the domesticated guinea-pig only the female progeny are fertile.

The hybrids produced by crossing *C. cutleri* with the domesticated guinea-pig are all fertile, and the results show that the colour varieties

* Philippine Journ. Sci., xi. (1916) pp. 110–17 (3 pls.).
† Comptes Rendus, clxiv. (1917) pp. 62–3.
‡ Carnegie Inst. Washington Publications, No. 241, pp. 1–192 (7 pls.).

of guinea-pigs have originated by loss variations or loss mutations. It does not follow, however, that the wild species have originated in this way. The two wild species, *C. cutleri* and *C. rufescens*, are probably distinct enough to show interspecific sterility, since one is known to form sterile hybrids, the other fertile hybrids, in crosses with the guinca-pig. Their specific distinctness accordingly cannot be due to such mendelizing factors as distinguish one domesticated variety from another, but to something more fundamental in character, though less striking in appearance.

Castle also reports on hybridization experiments with a race of feral guinea-pigs from Ica, Peru, and with a domesticated Arequipa race, and one of his general results is to confirm his previous conclusion (1909) that size inheritance is blending and does not mendelize. This does not preclude the possibility that in special cases mendelizing factors may exist which affect size. According to Castle, the hypothesis of quantitative variations in a blending character presents fewer difficulties as an explanation of size inheritance than the hypothesis of multiple unvarying segregating factors. His observations on rats and other rodents (1915) may be cited to show that even single mendelian unit characters are quantitatively variable.

The second study is by Sewall Wright, and deals with the inheritance of colour and of other coat characters in guinea-pigs, with especial reference to graded variations. He deals with the factors determining coloration, and with the various ways in which intermediates may arise between varieties which mendelize regularly. A complex of the most varied causes may underlie an apparently simple continuous series of variations.

In another set of studies, Castle deals with piebald rats and selection and with gametic coupling. Experiments with hooded rats point to the conclusion that the factor for hooded colour pattern may fluctuate in genetic value. Hence racial changes may be effected through selection by the isolation of genetic fluctuations, as well as by the isolation of mutations. Moreover, genetic fluctuation makes possible *progressive change* in a particular direction, repeated selection attaining results which it would be hopeless to seek by any other means. There is no natural limit to the progress which selection can make in changing the hooded character. It was found, however, that the long-continued inbreeding of the selected races affected their vigour and fecundity, as was observed by Darwin, Bos, Weismann, and others. In conclusion Castle discusses two yellow mutations in rats which show "mutual repulsion" in heredity.

Early Larval Stages of Eels.*—Johs. Schmidt has been able to throw further light on the life-history of the fresh-water eel, both the European eel (*Anguila vulgaris*) and the American eel (*A. rostrata*). In the case of the former, especially, his material is very abundant, embracing all stages, from a length of scarcely 9 mm. upwards to full-grown larvæ 88 mm. long. The succession is so complete that every

* Medd. Komm. Havund., Bd. v. (1916) pp. 1–20 (4 pls.).

single millimetre in the scale of length is represented. Particular attention is paid to the development of the teeth and of the anal and caudal fins. The changing proportions of the tail during development are discussed. Schmidt also gives an account of the differences between the fresh-water eels and other North Atlantic Muraenoids in their early ("preleptocephaline") larval stages, and defines four species.

Eggs of Gaff-topsail.*—E. W. Gudger gives a very interesting account of the way in which the male of *Felichthys felis*—a subtropical marine catfish—takes care of the eggs, incubating them in its mouth. From two to fifty-five eggs were found in the mouths examined, most of them 18–20 mm. in diameter, with very fluid yolk. They develop in the mouth till the young are hatched, when they are 85–100 mm. long. The enormous mouth is dilated when the eggs are in it, the gill-covers being widened outwardly and the hyoid distended downward. In the male that had fifty-five eggs in the mouth, the volume of the mouth was about 580 c.cm. The length of the period of incubation cannot be stated definitely, since it was not found possible, in spite of many attempts, to carry the development of the eggs on to the stage of hatching. It probably lasts about seventy days. During all this time the paternal nurse does not seem to feed. If the large eggs were spawned on sandy or shelly bottoms they would be destroyed by crabs or by fishes. If they were laid on a muddy bottom their considerable weight would cause them to sink into the mud, where they would be smothered.

b. Histology.

Comparative Study of Thymus.†—J. Salkind has made a comparaparative histological study of the thymus in mammals, birds, reptiles, amphibians, fishes, and lampreys. He inquires into the physiology and chemistry of the organ from the microscopical side. Starting from the parapharyngeal grooves in lancelets, the author regards the thymus as primarily a local differentiation of the enteric endoderm. In larval lampreys it has become an annex of the gill-pockets. In Selachians it keeps its correspondence with the gill-clefts, but is separated off as a lymphoid annex of the gills. In Teleosteans it loses its branchiomerism. In tadpoles a limited number of patches of epibranchial epithelium form the organ; in adult Batrachians it gets away from the alimentary tract and approaches the surface. In Sauropsida the superficial movement is more marked, the organ becomes more lateral and more distinct from the gut. But it retains its distinctive character as a lymphodization of an endodermic primordium as the result of connective proliferation. In mammals the lateral position is changed to a ventral one, which is acquired in very early embryonic stages. Throughout the series the thymus, as regards the lymphatic system, is a simple

* Zoologica, ii. (1916), p. 125–58 (12 figs.).
† Arch. Zool. Expér., lv. (1915) pp. 81–322 (3 pls. and 54 figs.).

sinus, but it becomes more and more rich in blood-vessels and nerve-ramifications.

The thymus is essentially a dual structure; there is a connective reticulum intermingled with an epithelial syncytium. To the second belong the secreting cells, Hassall's bodies, the plasmodes, cysts, and ciliated or mucus elements. To the former belong the lymphocytes, the phagocytes with multiple inclusions, the histogenic granulocytes, the globular pseudomyoid elements. In the lancelet the parapharyngeal groove is secretory, perhaps digestive. In the young Ammocœte the external secretion persists; in the old Ammocœte the secretion diminishes and the organ becomes lymphoid. In fishes the lymphoid function prevails, but there is also internal secretion. In adult amphibians the proper thymic function becomes twofold; the lymphocytes are leucopoïetic; the epithelial function plays a rôle only during inanition, when the secretion has a cytolytic influence.

The parapharyngeal grooves persist through life in *Amphioxus*; in the adult lamprey the organ loses its lymphoid population and becomes sclerous and fatty; the same regression is seen in attenuated form in fishes; in higher vertebrates the thymus disappears in adult life.

Structure and Function of Thymus.*—A. P. Duslin re-states his conclusion that only the small thymic cells represent the fundamental and specific part of the thymus. The epithelioid, myoid, ciliated, and other elements are inconstant and metaplastic. The small thymic cells are essentially proliferating elements, which form a nuclein-reserve distributed according to the needs of the organism. The thymus is one of the centres for the regulation of nuclein-metabolism.

Culture of Isolated Retina.†—Ch. Champy gives a detailed account of the behaviour of the various layers of the isolated retina of rabbit and tortoise. The degeneration of nervous and sensory elements varies in mode and rate. There is rapid pycnosis of the rods, the bipolar cells, the horizontal and amacrine cells. It is usually slower for the cones and ganglion cells. The last have most power of persistence, partly perhaps because of their abundant chromatic cytoplasm. The elements of the neuroglia survive and multiply, when the adjacent elements are dead. There is de-differentiation. Indifferent cells are formed which absorb the differentiated parts. There is evidence, therefore, that differentiated elements may become phagocytic.

Culture of Excised Thyroid.‡—C. Champy finds that the excised thyroid retains for a short time *in vitro* part of the normal activity of its tissues. There is a gradual cessation of a function, mainly automatic. Then de-differentiation begins. The thyroid cell shows direct division, and it absorbs its enclosed bodies. The proportion of vegetative to

* Arch. Zool. Expér., lv. (1916) Notes et Revue, No. 5, pp. 95–109.
† Arch. Zool. Expér., lv. (1914) pp. 1–18 (23 figs.).
‡ Arch. Zool. Expér., lv. (1915) pp. 61–79 (1 pl. and 11 figs.).

functional cytoplasm is normally large. The thyroid is only slightly differentiated, compared with many other organs, and its retrogression is therefore accomplished without striking transformations.

Structure of Digital Tendons.*—F. de Fénis points out that each long flexor tendon of the digits in man and mammals has the structure of two juxtaposed strings the fibres of which are twisted in opposite directions. This has the effect of uniformly distributing the effort of traction to all the fibres of the tendon. It is more marked in proportion to the activity of the tendon. The author discusses the mechanical factors in the evolution of this adaptation.

So-called Intestinal Glands in Necturus.†—H. T. Mead discusses the nature of certain protruding groups of cells embedded in the submucosa and connected to the mucosa. Groups of similar cells have been described in newts, salamanders and the like. As there is no lumen the protuberances cannot be glands. Cells in various stages of mitosis are frequent in all parts of the protuberance, but not in the mucosa at any considerable distance from a protuberance. It seems that the cells which are to compose the intestinal mucosa in *Necturus* are formed in these protuberances. They are centres for cell-proliferation, as has been concluded for some other Urodela by Bizzozero and Nicholas.

c. General.

Age-cycles and Periodicities in Organisms.‡—C. M. Child combats the idea that ageing is irreversible. The fact is that many cells, even in the higher animals, may undergo more or less de-differentiation as well as differentiation. Life is a cycle of alternating periods of senescence and rejuvenescence. The general metabolic rate in the simple animals, particularly certain Planarian worms, decreases from a very early stage in development; the rate of growth also decreases; in short, the animals undergo senescence. But a piece cut off undergoes more or less de-differentiation and internal re-organization, and usually develops into a new whole. It uses up part of its own body-substance as a source of energy and of the new cell material formed. The new individual is physiologically younger than the original animal, and the smaller the piece was the younger the new individual is. The new individual will grow old, and may be cut into pieces again. These will show rejuvenescence, and this alternation has been kept up experimentally for twenty generations. The process of reconstitution somehow brings about rejuvenescence.

Starved Planarians become gradually smaller. During the reduction the metabolic rate increases; they become younger. By feeding it is possible to stop the process of rejuvenescence. One species of

* Arch. Zool. Expér., lv. (1915) pp. 19–45 (22 figs.).
† Trans. Amer. Micr. Soc., xxxv. (1916) pp. 125–30 (1 fig.).
‡ Proc. Amer. Phil. Soc., lv. (1916) pp. 330–9.

Planarian, whose length of life under ordinary conditions in nature is about two months, was kept alive for nearly four years, in practically the same physiological state, by regulating the quantity and quality of the food. They got enough to prevent reduction in size, but not enough to permit of growth. Other members of the same original stock, fed in the usual way, had meanwhile passed through some twenty generations.

When the animal is adding to its protoplasmic substratum by growth and transforming it by processes of differentiation, it is growing old. When it is using up previously formed protoplasmic material, it is growing young. In the simple forms rejuvenescence is relatively easy; in the higher forms there is a physiological stabilization of the structural substratum.

The organism grows old when the primitive embryonic protoplasmic substratum is modified or added to by changes in the colloids and accumulation of relatively stable components by growth and differentiation, so that the process becomes less active chemically. The organism grows young when the protoplasm previously thus modified loses its modifications, approaches the undifferentiated condition, and becomes more active chemically.

Asexual reproduction in lower animals allows of much rejuvenescence. Sexual maturity usually occurs at advanced physiological age; the sex-cells are among the most highly differentiated and specialized cells in the organism; they are "old" cells. But there is evidence of physiological rejuvenescence in the early embryonic development.

The process of senescence by decreasing the effectiveness of the physiological integrating factors in the individual may lead automatically and necessarily to the physiological isolation of cells or parts, to reproduction of some sort, and to rejuvenescence. If the isolated part lives, it lives at the expense of its own substance and de-differentiation occurs. It becomes a more generalized whole until a new course of specialization begins.

Natural selection has unquestionably played a part in the evolutionary adjustment between the period of rejuvenescence and environmental conditions. Otherwise the period of de-differentiation and rejuvenescence would end in death. For a new period of differentiation following the rejuvenescence, nutrition from without is necessary.

Another periodicity is that of fatigue and rest. The substances producing fatigue are products of katabolism, which are soluble and readily removed. In age the retardation of metabolism is due to essential constituents of the differentiating protoplasmic substratum. Another parallel may be found in the loading of a gland-cell and its discharge; another in the diurnal loading of the leaf and the removal of the material at night; another in active periods and dormant periods. In many of these cases the organism responds to external rhythms in the environment, but there are minor periodicities in addition to the main periodicity of the age-cycle. The question is raised whether there may be a secular senescence of protoplasm in the life of the species, interrupted here and there by periods of rejuvenescence determined by environmental factors.

Albino Salamander.*—A. M. Banta and R. A. Gortner describe an albinotic (xanthic) larva of *Spelerpes bilineatus*, which was coloured a uniform yellowish orange, except for the gills, which were reddish from contained blood, and the eyes, which appeared opaque white. So far as the writers are aware this is the only certain wild albino Urodele on record. An albino strain of the axolotl has been reared in captivity for nearly half a century. The cave-inhabiting *Proteus anguineus* is sometimes referred to as an albino, but pigment develops in individuals kept for some months in daylight.

INVERTEBRATA.

Mollusca.

γ. Gastropoda.

Spermatogenesis in Columbella.†—Victor Schitz finds that there are two developmental cycles in the spermatogenesis of this Prosobranch, as others have found in *Paludina*, *Cerithium*, *Murex*, *Conus*, and *Vermetus*. There is a typical and an atypical cycle. The mitochondria play an important part in both cycles. They form the tail in the typical cycle, in the other a sort of envelope for the whole spermatozoon. The idiozome of the atypical series corresponds to the "Nebenkern" of Pulmonata and the internal reticular apparatus of Golgi. The author describes the development of the intra-nuclear rod, the acrosome, and the centrosome and axial filament, in which there is little that is peculiar.

Float of Ianthina.‡—V. Baldasseroni refers to the float by means of which this mollusc remains on the surface of the sea and is wafted about. In the female the eggs are enclosed in a capsule suspended to the under-surface of the float. Some observations on *Ianthina nitens* lead the author to think that the float is likewise protective. The shape seen from above is a pointed oval, with a dorsal keel. It has a remarkable resemblance to a small mass of foam, and the eye is easily deceived. This may protect the eggs, but perhaps it also saves the molluscs themselves from sea-birds and other enemies. For the animal hides under the float when disturbed.

δ. Lamellibranchiata.

Entovalva.§ — R. Anthony decribes the remarkable commensal bivalve known as *Synapticola perrieri* Malard, which should be called *Entovalva perrieri* Malard. It is found firmly fixed to the posterior

* Proc. U.S. Nat. Museum, xlviii. (1916) pp. 377–9 (1 pl.).
† Arch. Zool. Expér., lvi. (1916) Notes et Revue, No. 2, pp. 32–47 (6 figs.).
‡ Arch. Zool. Expér., lv. (1915) Notes et Revue, No. 1, pp. 5–7 (1 fig.).
§ Arch. Zool. Expér., lv. (1916) pp. 375–91 (2 pls. and 8 figs.).

body of *Synapta inhærens*. When it is separated it moves by means of its well-developed foot. As Malard showed, there is a minute delicate shell incompletely covered by the reflected lobes of the mantle; the mantle has an anterior pedal opening and a posterior siphon; the pallial papillæ are strongly developed; the gills have one lamella; the posterior pallial cavity forms a brood chamber. Anthony finds that the prodissoconch is clearly visible; that the elastic portion of the ligament is internal; that there are two adductors, two anterior retractors, and two posterior retractors of the foot; that the pallial line is without a sinus; and that the labial palps are very distinct. The genus is nearly allied to *Montacuta*, but the resemblances to *Scioberetia* are perhaps due to convergence.

Structure of Solen.*—Ekendranath Ghosh gives an account of the structure of what seems to be a dwarfed form of *Solen fonesi*, from Chilka Lake. The siphon-wall consists of outer columnar cells on a distinct basement membrane; a thick layer of connective tissue with many elastic fibres and connective-tissue corpuscles; a thick longitudinal layer of muscle-fibres, grouped into radial bundles; a thin layer of connective tissue; a thin layer of transverse muscle-fibres; a thin layer of longitudinal muscle-fibres; another thin layer of transverse muscle-fibres; and a layer of columnar epithelium lining the canals. The digestive, nervous, and excretory systems are described in some detail.

Arthropoda.

a. Insecta.

Rôle of Pericardial Cells in Insects.†—A. Ch. Hollande publishes a preliminary paper on the physiological rôle of the pericardial cells which are disposed, in insects, round the cardiac sinus, and connected with each other and with the sinus by striated muscle-fibres and fine smooth fibrils. There are usually two nuclei in a cell. These cells, which have usually been considered excretory, have the function of absorbing albuminoid substances of alimentary origin, and rendering them assimilable. During metamorphosis the pericardial cells persist without modification, and, with rare exceptions, continue to function by absorbing the albuminoid substances liberated into the blood either as a result of phagocytosis or of the breaking down of larval cells.

The acid reaction of the pericardial cells is apparently due to the presence of phosphates. The cells are not in any true sense excretory; they are glandular elements which transform and modify the substances which they absorb, the transformations being due in part to reducing agents acting in an acid medium. Throughout the life of the insect the pericardial cells absorb the oxidized products resulting from the action of the phagocytes, and return them to the blood in a reduced form. Finally, these cells neutralize the alkaline products which arise in the course of metabolism, and render them innocuous.

* Memoirs Indian Museum, v. (1916) pp. 367–74 (3 figs.).
† Arch. Expér. Zool., lv. (1916) pp. 67–84.

Insects and Disease.*—A very useful guide has been prepared dealing with the specimens and models exhibited in the Central Hall of the British Museum (Natural History), which illustrate the importance of insects in connexion with the spread of disease. The guide deals with mosquitoes and malaria, mosquitoes and yellow fever, mosquitoes and filariasis, fishes that feed on the larvæ of mosquitoes, tsetse-flies and trypanosomiasis, Tabanid flies and "Calabar swellings," house-flies and intestinal diseases, sheep bot-fly, fleas and plague, bed-bugs and disease, lice and disease, ticks and disease.

Chromosome Studies in Diptera.†—Charles W. Metz has studied the chromosomes of about eighty species of Diptera with especial reference to the phenomenon of "chromosome pairing." In all cases the chromosomes were found to be uniformly associated in pairs in diploid cells, whether somatic or germinal. The paired association was found to continue throughout all stages of cell-division from earliest prophase to latest anaphase, being most intimate in the earliest and later stages. Association of paternal and maternal chromosomes apparently is effected in early cleavage stages (perhaps before the first cleavage), since in the late cleavage stages the chromosomes are definitely paired. The paired association was found to continue during all stages in ontogeny from the egg to the adult.

Certain cases of multiple chromosome numbers (tetraploid or higher multiples) were found in occasional cells. In these cases corresponding chromosomes were associated together in prophase in aggregates of four, eight, etc., instead of being arranged in pairs. In many species several pairs of chromosomes (in some cases nearly all) could be individually distinguished by characteristics of size and form. In a species of *Drosophila* each pair of chromosomes is very clearly differentiated from all others. These individually marked pairs of chromosomes, with the exception of the sex-chromosomes in males, were in all cases symmetrical, i.e. composed of similar members. In certain respects the pairing phenomena were found to present a striking similarity to synaptic phenomena. They give an actual demonstration of a side-by-side approximation of corresponding chromosomes.

The facts lend strong support to three conclusions: (1) that the paired arrangement of chromosomes is not due to a random assorting process, but is selective to the highest degree; (2) that each maternal chromosome becomes associated with a definite, similar paternal chromosome and with no other; and (3) that chromosome pairing is dependent upon the qualitative nature of the chromosomes—and more specifically upon a qualitative (physico-chemical) similarity between associating members.

Viviparity in Diptera. ‡—D. Keilin divides those Diptera which are always viviparous into two groups. First, there are those in which the larvæ are not nourished in the uterus of the mother, where only the

* British Museum (Nat. Hist.) 1916, Special Guide No. 7, 45 pp. (14 figs.).
† Journ. Exper. Zool., xxi. (1916) pp. 213–79 (8 pls.).
‡ Arch. Zool. Expér., lv. (1916) pp. 393–415 (8 figs.).

embryonic development proceeds—e.g. some Tachinariæ, Dexiidæ, all the Sarcophagidæ, various Anthomyidæ (e.g. *Musca larvipara* and *Mesembrina meridiana*). Second, there are those in which the larvæ pass all their time in the maternal uterus, some being born as larvæ (e.g. *Glossina*), and others as pupæ (e.g. *Hippobosca*, *Melophagus*, and *Ornithomyia*). The larvæ of the second set exhibit some special characters related to the intra-uterine nutrition. Thus the bucco-pharyngeal apparatus is reduced to the basilar plate, a convergence to which is seen in some parasitic larvæ. Moreever, the salivary glands disappear, the mid-gut does not communicate with the hind-gut, and the respiratory apparatus is metapneustic in all the three stages of larval life.

Portchinsky has interpreted the viviparity as an adaptation arising in coprophagous forms, where it is advantageous in reducing the coprophagous period. Roubaud gets back to primary causes in associating viviparity with rich diet and high temperature. Keilin regards this as too simple, for the conditions might simply lead to more eggs and more ovipositions. It must be remembered, moreover, that the larva is as peculiarly adapted to its intra-uterine life as a parasitic larva to its host.

Structure of Ptychoptera albimana.* — Émile Topsent describes some of the minute structures of this fly (Nemocera), e.g. the structure of the egg-envelope, the setæ of the larva, the so-called tracheal gills which have a dubious respiratory significance, and the otocysts.

Habits and Parasites of Common Flies.†—G. S. Graham-Smith has reached the following conclusions as the outcome of prolonged observation and experiment. In the common species the very great majority of individuals pass the winter as pupæ, or more rarely as larvæ which pupate early in the spring. The pupæ or larvæ lie under shelter on the surface of the ground, or more commonly at a depth of two or three inches. A very small and unimportant minority of both sexes, emerging from pupæ late in the autumn or even in the winter, possibly survive as adults till the spring. It is very improbable that many of the females with this history are impregnated in the autumn, or that most of them reach sexual maturity much earlier than the broods emerging in the spring. The wintering habits of *Musca domestica* are still obscure.

The time occupied by the various stages between the rupture of the puparium and full formation varies with the temperature. The majority of the specimens of each species only emerge from "winter" pupæ after the mean temperature of the surrounding materials reaches a "critical" point. This is about 48°–50° F. for *Calliphora erythrocephala*, *Fannia manicata*, *F. scalaris*, and about 63° F. for *Ophyra leucostoma*. In several species the majority of males emerge before the females. Flies emerging from "winter" pupæ seem to be the most hardy. Many of

* Arch. Zool. Expér, lv. (1916) Notes et Revue, No. 5, pp. 81–94 (9 figs.).
† Parasitology, viii. (1916) pp. 440–544 (8 pls., 17 figs., and 9 charts).

the flies of subsequent generations only live a few days, and never reach sexual maturity.

The estimations of the multiplication of flies during the fly season are much exaggerated. Among blow-flies confined in large open cages and protected from many enemies and certain adverse conditions, the descendants of each female only numbered 130 individuals. Amongst "wild" flies the increase must be considerably smaller. The normal duration of life among blow-flies is about thirty days in the summer. A considerable mortality often follows cold, wet, and windy days. Oppressive sultry weather is productive of the greatest mortality. Flies die if exposed to very hot sunshine.

During the season many different flies enter rooms, most by accident, but *C. erythrocephala*, *Stomoxys calcitrans*, *F. canicularis*, and *M. domestica* by intention. The different species vary in their occurrence at different seasons. Those that require a high "critical" temperature for emerging from pupæ appear late and disappear early. The disappearance of flies in autumn is not due to the effect of cold on the adults, but to the non-emergence of flies from pupæ. The conditions limiting numbers include the destruction of larvæ and pupæ by Braconid and Chalcid parasites and other enemies, lack of food for the larvæ, the appetite of other species of larvæ, the enemies of the adults, and the weather. Baited traps in the open catch many flies; dark or shaded receptacles catch few. Only about 16 p.c. of the flies that visit human excrement and decaying animal matter are males; they seldom venture into dark receptacles. All the species of flies that visit excrement and decaying animal matter also visit fruit. There is great contamination of fruit (on trees and exposed for sale) with fæcal and putrefactive bacteria carried by flies and wasps.

The activities of flies are most affected by temperature. The larvæ of *Hydrotæa dentipes* devour other fly larvæ. Burial of dead animals does not prevent the development of the larvæ present on them, nor the emergence of the flies. It is probable that wasps act not infrequently as agents in disseminating pathogenic and putrefactive bacteria. Contact with infected adults of *M. domestica* is not essential in the transmission of Empusa disease. The house-fly may be infected by *C. erythrocephala*, *H. dentipes*, and *F. canicularis* which occasionally die of the disease.

Various mites attach themselves to flies for several days. They may act as carriers of Nematodes. The Pseudo-scorpions (*Chelifer nodosus* and *C. scorpioides*) sometimes occur on flies for several days. Braconid larvæ pass the winter in fly puparia, and so do some Chalcids.

Gynandromorphous Butterflies.*—E. A. Cockayne discusses gynandromorphism in *Agriades coridon*, ab. *roystonensis*. There is some evidence that it runs in families at Royston on the borders of Hertfordshire and Cambridgeshire. Careful dissection was made of twenty-five undoubted cases, and the peculiarities of the genital system (always female internally and externally) are described. As regards external

* Trans. Entomol. Soc., London, 1916, pp. 243–63 (9 pls. and 9 figs.).

appearance the forms may be classified in three groups: unilateral or halved, bilateral, and crossed gynandromorphism. The dissimilarity on the two sides is seen in the presence of male scent scales or androconia, coarse blue hair, and blue scales of the ordinary shape.

It is probable that ordinary gynandromorphs are produced by unequal chromosome divisions at the first cleavage of the normally fertilized ovum, and that in this unequal division both the units for sex and for secondary sexual characters participate. Hence such individuals are likely to be true genetic hermaphrodites, having the gonad, external genitalia and secondary sexual characters peculiar to one sex on the one side, and those peculiar to the other on the other side. In the Royston gynandromorphs, however, internal and external genitalia were always female. The irregular division cannot therefore have affected the factor for sex, but only the factor for certain secondary sexual characters.

Male Scales of Lycænidæ.*—L. G. Courvoisier finds that the male scales or androconia are specific in distribution, size, form and structure. The peculiarities are constant for the species. Different species may have closely similar androconia, but there is always detailed specificity. They afford convenient and reliable criteria in the identification of species. They are connected by transitional forms with ordinary scales.

External Features of Ants.†—Carlo Emery begins a systematic account of Italian Hymenoptera with the family Formicidæ, and gives in his introduction a useful account of the detailed structure of the head, the antennæ, the thorax, the abdominal peduncle, the abdomen, the genital armature of the male, and the wings. Then follows the survey of genera and species.

New Parasitic Hymenopteron.‡—Ch. Ferrière describes *Anteris nepæ* sp. n., which, like *Prestwichia aquatica*, develops parasitically in the eggs of *Nepa*. It destroys the eggs. In the same way, the author recalls, *Caraphractus cinctus* Walker (=*Polynema natans* Lubbock) is often found in the eggs of *Calopteryx*, and also occurs in those of *Notonecta*; *Prestwichia aquatica* Lubbock in eggs of Hemiptera, Dytiscidæ, Libellulidæ; *Typhodytes gerriphagus* Marchal and *T. setosus* Stéfani-Pérez in eggs of *Gerris*; and *Litus cynipseus* Halid. in the eggs of *Limnobates stagnorum*.

Life-history of Braconid Parasite.§—The late G. de la Baume-Pluvinel (killed at the front near Ypres) describes the stages in the life-history of *Adelura gahani* sp. n., an internal parasite of a Dipterous larva, one of the Phytomyzinæ, which mines in the leaves of Ancolias. The parasite makes no cocoon; it undergoes no metamorphosis in the puparium of its host. There are three well-defined larval stages. The first has a marked concavity on its ventral surface, and resembles

* Verh. Nat. Ges. Basel, xxviii. (1916) pp. 11–48 (2 pls.).
† Bull. Soc. Entom. Ital., xlvii. (1916) pp. 79–275 (92 figs.).
‡ Arch. Zool. Expér., lv. (1916) Notes et Revue, No. 4, pp. 75–80 (4 figs.).
§ Arch. Zool. Expér., lv. (1915) pp. 47–59 (1 pl. and 3 figs.).

what Keilin and Picado have described in *Diachasma*. It has locomotor appendages, primordia of the adult's internal organs, well-formed empty tracheæ without open stigmata. It moults and passes into a second transition-phase. The third phase is helminthoid. The parasites hibernate as larvæ, and become winged insects after a short nymphal period.

Studies in Dyticidæ.*—F. Brocher continues his interesting studies on *Dyticus marginalis* and *D. punctulatus*, describing two pulsating aspiratory organs (scutellar and metatergal) which seem to facilitate the circulation of the blood in the wings and in the elytra. The dimensions are about 1 mm. by 2 mm., large in comparison with various pulsating organs which have been observed in other insects. In another paper† the author discusses the process of respiration in detail. He calls attention to the periods of somnolence, lasting ten to fifteen minutes or more, during which there are no respiratory movements. When *Hydrophilus* breathes at the surface it uses the pro-mesothoracic stigmata, and shows rapid respiratory movements of the body, about twenty in a minute. When *Dyticus* breathes at the surface it inspires by the abdominal stigmata, and shows usually one inspiration. If it is in critical need of air, it sometimes shows four or five rather weak inspirations in a minute. Thus there is considerable diversity in the modes of respiration.

Abnormal Limb in Beetle.‡—T. A. Chapman describes an unusual abnormality in a beetle from the Bristol Museum, labelled *Odontopus cupreus* (?), Portuguese East Africa. The third tarsal joint leads on to the rest of the limb as usual, but gives off also an additional part with two joints. These additional joints arise dorsally, and perhaps a mediodorsal portion of a normal tarsus has been reduplicated to form them.

Salivary Glands of Male Panorpa.§—L. Mercier calls attention to the large development of the salivary glands in the males. In a young imago, four or five days after emergence, they may be 2–3 mm. long; in one of eight days they may be 12–15 mm. This does not seem to be connected with nutrition, for the young and the larvæ feed just as the adults do, and the two sexes are alike in their nutritive relations. Observation of the pairing discloses a remarkable fact. The male emits on the ground a drop of salivary secretion about the size of a pin's head. This coagulates and looks like a pearl. The male removes himself a little way. The female attacks the pearl with her rostrum and envelops it with a brownish fluid from her crop. She remains immobile, working at the hard drop, which she reduces to an irregular magma. Meanwhile the male pairs with her. A second drop is often used, perhaps after an interval of twenty minutes. The pairing process lasts for about an hour; so if the female rejects or finishes with the

* Arch. Zool. Expér., lv. (1916) pp. 347–73 (11 figs.).
† Arch. Zool. Expér., lvi. (1916) pp. 1–24 (6 figs.).
‡ Trans. Entomol. Soc. London, 1916, pp. liv–lv (1 fig.).
§ Arch. Zool. Expér., lv. (1915) Notes et Revue, No. 1, pp. 1–5 (1 fig.).

first pearl, the male supplies another. The large size of the glands is correlated with this peculiar function. It may also be that the secretion is not merely attractive but aphrodisiac. It is noted that in the Empid *Bittacus* the male seizes the female while she is devouring her prey. In a North American grasshopper, *Œcanthus fasciatus*, the female before pairing licks the secretion from a special gland on the centre of the metanotum of the male. In the black slug (*Arion*) the caudal muciparous gland secretes a large globule which each slug devours with avidity from off its partner.

Study of Nepa.* — F. Brocher has made a detailed study of the tracheæ (in larva and imago), the stigmata and siphon, the air-sacs and other accessories of the tracheal system, the respiratory movements and muscles, the circulation of the air, the life-history, and the question of flight. The "tracheo-parenchymatous organ" is homologous with the large longitudinal dorsal muscle of the thorax; certain sheets of tissue associated with the air-sacs are homologous with other muscles in other types. As in most insects expiration is mainly due to the contraction of the dorso-ventral abdominal muscles; inspiration is passive. After thorough ventilation of its tracheæ, the insect expires some reserve air underneath the elytra. Brochet does not think that *Nepa* can fly at all.

Homœotic Regeneration of Antennæ of Phasmids.†—H. O. Schmidt-Jensen, experimenting with *Carausius* (*Dixippus*) *morosus*, found that the removal of the antennæ was followed by homœotic regeneration—that is, by the growth of a part with the characters proper to another member of the series. What was re-grown was a limb-like appendage, e.g. with a claw-joint and three small short tarsal joints. In the most pronounced cases there was a tibia-part as well. Amputations across the basal joint, or between this and the second joint, produce dwarfed, slightly developed homœotic regenerations, while amputations across the basal joint, or between the second and third joints, cause strong well-developed homœotic regenerations.

Anoplura and Mallophaga from Birds and Mammals.‡—Bruce F. Cummings continues his account of representatives of these orders found on birds and mammals in the Zoological Gardens, London. He establishes four new genera of Philopterid Mallophaga—*Anatœcus*, *Neophilopterus*, *Ibidœcus*, and *Dollabella*, and a new genus, *Struthiolipeurus*, in the family Lipeuridæ.

Mouth-parts of Body-louse.§—Launcelot Harrison gives an account of the much-discussed mouth-parts of *Pediculus humanus* L. (usually

* Arch. Zool. Expér., lv. (1916) pp. 483–514 (20 figs.).

† Report Smithsonian Institution for 1914 (published 1915) pp. 523–36 (2 pls.). See also Vidensk. Meddels. Dansk. Naturhist. Forening, lxv. (1913) pp. 113–34.

‡ Proc. Zool. Soc., 1916, pp. 643–93 (36 figs.).

§ Proc. Cambridge Phil. Soc., xviii. (1916) pp. 207–26 (1 pl. and 7 figs.).

referred to *P. vestimenti* Nitzsch, occasionally as *P. corporis* Degeer.) In 1866 Schiödte proved the suctorial nature of the apparatus, but the structure has remained something of a mystery, and the homologies are obscure.

The stomodæum is divisible into buccal cavity, pumping-pharynx. pharynx proper, and œsophagus. Upon the floor of the buccal cavity, near its hinder end, opens a long invagination, the piercer-sheath, which extends beneath the alimentary canal back almost to the occiput, and contains the piercing apparatus. Within the piercer-sheath lie four structures directly continuous with six chitinous tendons into which six muscles rising from the posterior wall of the head-capsule are inserted. The tendons of the dorsal muscles are continued into the dorsal-piercer; the tendons of the lateral pair of muscles concresce as the ventral-piercer; the tendons of the ventral muscles expand into a chitinous plate, separable into anterior and posterior portions, which lies embedded in the floor of the sheath. These plates may represent the mentum and submentum of the labium. The fourth structure is a delicate chitinous duct, probably the salivary duct. One important part of the apparatus has hitherto escaped notice altogether—the buccal tube. This is a tube lying free within the buccal cavity, composed of two lateral apposable half-tubes which arise ventro-laterally from the floor of the fore-gut at the point of junction of the buccal cavity and pumping-pharynx. Into the lumen of the tube thus formed enter the dorsal and ventral piercers, and the salivary duct. All these parts are dealt with in detail.

The method of feeding is as follows. When the louse has selected a spot, the haustellum is protruded by protraction of the buccal plate, and a superficial fixation effected by the buccal teeth. The same action brings the buccal tube into contact with the skin, and the contained piercing apparatus enters the tissues of the host, and penetrates to the level at which blood is reached. Salivary-secretion accompanies the piercer, and possibly contains an anti-coagulin and also has some solvent action. The pumping-pharynx commences its rhythmical dilations, by means of which blood is drawn in through the buccal tube, and passed backwards to the pharynx, where, by means of alternate contraction of the sphincters and dilatation of the dilatators, it is pumped backwards into the œsophagus, by the peristaltic action of which it is carried to the stomach. At the close of the feeding-process, the piercer is drawn in by its own retractors, the retractors of the labium serving to pull the sheath back. The retractors of the buccal cavity draw in the haustellum and buccal tube.

The author maintains that Mallophaga and Anoplura are beyond all question closely related, and that the Anoplura are distinctly nearer, in a great many features, to the Ischnocera than to the Amblycera. The mandible and maxilla may be dismissed as far as any participation in the actual mouth-parts of Anoplura is concerned. The mentum and submentum may be represented by the two plates lying in the floor of the piercer-sheath. The buccal tube and the piercing apparatus are probably altogether due to transformations of the Mallophagan hypopharynx.

δ. Arachnida.

Mating in Cribellate Spiders.*—Jeanne Berland has studied the mode of copulation in cribellate spiders, especially in *Dictyna vividissima*, a small form in which the female is of a delicate green colour, while the smaller male has the cephalothorax and appendages rust-coloured and the abdomen green. The two sexes are usually found in their different retreats on the surface of a large green leaf, such as that of *Aralia*, or, more often, one on the upper and one on the under side. The whole process of wooing and mating is described and illustrated. A distinctive feature is that the cheliceræ of the female grasp those of the male, and this position is maintained throughout. The web of this species and of *Filistata testacea* is also described and figured, and a preliminary note made as to the function of the cribellum and calamistrum.

New Mites from Lizards.†—Stanley Hirst describes some new mites from lizards—two new species of *Pterygosoma*; a new genus, *Geckobiella*, nearer to *Pterygosoma* than to *Geckobia*; seven new species of *Geckobia*; and *Pimeliaphilus tenuipes* sp. n. With the probable exception of the last, all are true blood-sucking parasites.

Evolution of Indo-Australian Thelyphonidæ.‡—F. H. Gravely takes a survey of the known forms, and finds that evolution has chiefly affected three structures: (1) the tibial apophyses of the male (probably in connexion with sexual processes); (2) the tarsi of the antenniform legs of the female (at about the place where the male holds them between his chelicerae during courtship); (3) the genital sterna of both sexes. The geographical distribution of the genera is discussed in relation to these characteristics.

Cavernicolous Acarina.§—L. G. Neumann reports on forty-three collections of Ixodidæ from different grottos. Most of them consist solely of *Ixodes* (*Eschatocephalus*) *vespertilionis* C. L. Koch, which is truly cavernicolous. The only other species is *I. hexagonus*, introduced into grottos by small mammals. In the first-named species the adult males were never found except on the walls of the grotto; the parasitism on bats seems to be restricted to larvæ, nymphs, and females.

ε. Crustacea.

Revision of British Idoteidæ.—Walter E. Collinge has revised the British representatives of this family of marine Isopods. A useful

* Arch. Zool. Expér., lv. (1916) pp. 53–66 (8 figs.).
† Ann. and Mag. Nat. Hist., xix. (1917) pp. 136–43.
‡ Records Indian Museum, xii. (1916) pp. 59–85 (4 pls.).
§ Arch. Zool. Expér., lv. (1916) pp. 515–27 (1 pl.).
‖ Trans. R. Soc. Edinburgh, li. (1917) pp. 721–60 (11 pls.).

account is given of the external structure of the body and its appendages. Apart from size, endless diversity of colour-markings, and slight deviations in the mandibles and maxillæ, very few variations were met with in the large number of specimens examined. In *Idotea baltica* there is remarkable power of individual colour change. The author describes *I. sarsi* sp. n., and, for reasons given, replaces the generic name *Stenosoma* by *Synisoma*. Besides *Idotea* and *Synisoma*, the author includes in his British representatives the genus *Zenobiana*. Most Idoteids live among masses of decaying algæ, and feed on dead fishes, molluscs, crustaceans, annelids, etc. Their chief enemies are fishes.

Variation of the Appendages bearing Pseudo-tracheæ in Terrestrial Isopods.*—Walter E. Collinge finds considerable diversity in regard to these structures in different examples of the same species. They are not suited for generic or specific distinction. In Oniscoida the appendages in question are plate-like in structure, with the exception of the sixth. Each consists of an inner plate, the endopodite, which functions as a branchial organ, and an outer plate, the exopodite, which covers and protects the former. In some genera, e.g. *Porcellio*, *Porcellionides*, *Cylisticus*, *Armadillidium*, and *Eluma*, air tubes, or pseudotracheæ, are present in the outer plate on the first and second appendages, and sometimes on the three succeeding ones as well. In a single species, e.g. *Porcellio pictus*, there is considerable variety as to the number of appendages in which the air-tubes occur.

Idotea lacrustris.†—Walter E. Collinge discusses the structure and generic position of *Idotea lacustris* Thomson. The species should be referred to Richardson's genus *Pentidotea*, which combines the possession of a five-jointed palp of the maxillipede with the presence of a metasome of only three segments. Hitherto the genus has been known only from the Northern Pacific; but Thomson's species were from a fresh-water stream, Mt. Mihiwaka, Otago, and from Dunedin Harbour

Amphipoda montagui.‡—H. Chas. Williamson describes an amphipod which he proposes to call *Amphipoda montagui* (M.–Edwards). It is the same as *Isæa montagui* M.–Edwards. Specimens were found on lobsters, lurking about the maxillipedes and middle ventral line of the thorax. "In order to attain the principal objects of classification (which are (1) given the name of the animal to find the description, and (2) given the animal to find out the name which has been attached to it), the sub-division of the animal kingdom does not require to be carried out on a scale beyond that which makes Amphipoda a descriptive name. If the species here dealt with had been named *Amphipoda montagui*, all zoologists would have known something about it, whereas under Edwards' name, *Isæa montagui*, it is altogether unknown to ninety-nine out of one hundred zoologists."

* Journ. Zool. Research, i. (1916) pp. 159–60.
† Journ. Zool. Research, i. (1916) pp. 153–7 (1 pl.).
‡ Journ. Zool. Research, i. (1916) pp. 135–49 (29 figs.).

Annulata.

Vitelline Membrane of Serpulids.* — A. Soulier finds that this membrane persists in *Serpula crater* on to the trochophore stage, having a protective rôle throughout. The posterior end of the trochophore breaks through, and the membrane gradually disappears from behind forwards. The same persistence and disappearance is to be seen in *Hydroides pectinata* and *Protula meilhaci.*

Polychæts of Falkland Islands.†—Pierre Fauvel reports on a collection, mostly littoral, made by Rupert Vallentin. It is interesting to find the same species occurring in regions so far separate as Norway and Tierra del Fuego, the Arctic Ocean and the shore of the Antarctic Continent. Far over sixty species occur in both hemispheres. Temperature is an important factor in determining the distribution. Many species are cosmopolitan, and it is important to compare these so as to eliminate individual variations or modifications. Claparède has criticized some of de Quatrefages' "variétés alcooliques."

Structure and Reproduction of Naidomorpha. —Lucienne Dehorne has made a careful study of *Chætogaster diaphanus* and *Stylaria lacustris*, two typical Naidomorph Oligochæts. The epidermis shows highly differentiated tactile cells. The basal prolongation of each traverses the musculature and comes into relation with one of the bipolar cells of an intermediate ganglion, which brings it into relation with the multipolar cells of the nerve-centres. These sensory elements are most abundant on the cephalic lobe, but occur isolated all over the body.

The swelling of the mid-gut, sometimes called stomach, has an intra-epithelial reticulum which may be branchial in function. There is a complex intra-epithelial vascular system on the intestine. The chloragogen investment is separated from the intestine by the basal membrane, a lacunar blood system, and the intestinal muscles. The chloragosomes seem to be excretory digestive products forced into the blood. The nerve-chain has no neurochord. Each cerebroid mass in *Chætogaster* has a sensory organ embedded in a mass of ganglion cells. The "chitinoid platelet" of Vejdovsky consists of two or three flattened ganglion cells, forming a cap on the median lobe of the brain. The epithelial eyes of *Stylaria* are fully described. All the Naidomorphs become sexual at a particular season, and all show the same complex reproductive system.

The zones of scissiparity are always situated in a particular segment, behind the septum. Besides the normal scissiparity seen by itself in *Dero* and *Ophidonais*, there is in all the others a second mode, a precocious scissiparity, and this differs in *Naïs* and *Stylaria* types. It is the

* Arch. Zool. Expér., lvi. (1916) Notes et Revue, No. 1, pp. 16–20 (3 figs.).
† Arch. Zool. Expér., lv. (1916) pp. 417–82 (2 pls. and 6 figs.).
‡ Arch. Zool. Expér., lvi. (1916) pp. 25–157 (3 pls. and 88 figs.).

epidermis that plays the chief genetic rôle. The whole process of budding and scissiparity is discussed in detail.

Individuals which are becoming sexual continue to bud and to reproduce by scissiparity until they are mature. In *Chætogaster* the asexual process continues during the reproductive period. Every zooid separated by budding from a sexual individual is also sexual, and the genital primordia in the zooid are developed in proportion to the state of gonadial development in the parent. The reproductive period does not end in death ; the gonads retrogress, and the posterior end of the body begins or continues to bud off new segments. Epigamic phenomena are most marked in those Naidomorphs that live in favourable conditions of life.

Structure of New Species of Branchellion.*—W. Harold Leigh-Sharpe describes *Branchellion australis* sp. n., from a skate caught at Port Victor, South Australia. There are thirty-one pairs of gills, instead of thirty-three in *B. torpedinis*, the pigmentation is different, and there seem to be no eyes, whereas *B. torpedinis* has six. It may be noticed that respiration is carried on not only by the foliaceous branchiæ, but also by rounded vesicles protruding from the abdominal portion of the body. "Vesicles are common in other genera, and I have seen them rise and fall by pulsation in *Calliobdella lophii.* They receive lymph, which after aeration is returned to the lateral sinus, so that respiration is lymphatic." The author contributes some interesting sections.

New Ichthyobdellid Parasite.†—Charles Badham describes *Austrobdella translucens* g. et sp. n., a small transparent leech, a fatal parasite on the fins of the sand-whiting (*Sillago ciliata*) in New South Wales. There are well-defined neck and body regions ; the body is cylindrical in the young, much flattened in the adult ; the lateral parts of the body below the clitellum bulge out and form a shoulder-like appearance ; a somite has six annuli ; there are no pulsating vesicles, their place being taken by a continuous contractile lacuna placed on either side outside the body musculature ; there are dorsal and ventral median lacunæ, communicating by segmental lacunæ ; there are three pairs of pouches in the thick-walled intestine, and a fourth pair is represented by a flexure of the gut ; there are five pairs of testes ; there is one pair of eyes.

Platyhelminthes.

Bilharziosis.‡— R. T. Leiper makes another contribution to his study of vesical and intestinal bilharziosis. Hæmaturia occurs in not less than half of the total population of Lower Egypt. The bleeding is due to erosion of the mucous membrane by innumerable minute hard-shelled eggs, which are made to move by the contractions of the

* Trans. R. Soc. South Australia. xl. (1916) pp. 42–55 (9 figs.).
† Quart. Journ. Micr. Sci., lxii. (1916) pp. 1–41 (2 pls. and 6 figs.).
‡ Proc. Roy. Soc. Med., ix. (1916) pp. 145–72 (25 figs.). See also Bull. Inst. Egyptien, x. (1916) pp. 217–27.

bladder. Asiatic bilharziosis is transmitted by species of *Bythinia*, Egyptian bilharziosis by *Bulinus*, *Planorbis*, and *Melania*. Besides *Bilharzia hæmatobium* of man there is in Egypt *B. bovis* in cattle, and *Bilharziella polonica* in ducks. Leiper has succeeded in artificially infecting monkeys, guinea-pigs, rats, and mice, the animals being placed in shallow water into which large numbers of cercariæ had been liberated. The tail is discarded at the moment of infection and the body burrows into the lymph vessels and blood vessels. Thence the parasite reaches the liver where the cercarial body undergoes gradual growth and differentiation. The sexes are first distinguished by the broadening out of the males in the early stages of their growth in the liver. The females commence to produce eggs in six to ten weeks after infection.

Animals infected with cercariæ from *Bulinus dybowski*, etc., always produce adult worms which give rise to terminal-spined eggs only, while those infected with cercariæ from *Planorbis boissyi* give rise equally constantly to lateral-spined eggs. In no case do both varieties arise from the same intermediate host. The terminal-spined eggs give rise to *B. hæmatobium* (*sensu strictiore*), the lateral-spined eggs to *B. mansoni* (Sambon). The males of *B. hæmatobium* appear to leave the liver early, and to pass down into the finer branches of the mesenteric vessels before they attain maturity. The females found in the gynæcophoric canal are diminutive. The males of *B. mansoni* remain in the liver until the females *in copulâ* begin to lay eggs, and large numbers of lateral-spined eggs are frequently laid in series by coupled worms in the veins even on the edge of the liver. The eggs found in bilharzial cirrhosis of the liver may have been laid there, not carried thereto from the mesenteric vessels as has hitherto been supposed.

Asiatic Schistosomiasis.*—R. L. Leiper and E. L. Atkinson give an account of their mission to the Far East to investigate the mode of infection in Asiatic schistosomiasis (bilharziosis). Working from Shanghai, they visited many infected districts in China and Japan in search of material for experimental study. The Looss hypothesis of direct infection was discarded in favour of one to the effect that the schistostome conformed in essentials to the life-cycle of other digenetic trematodes. After a search of three months, involving a journey of 1000 miles, a dog was found heavily enough infected to yield eggs that could be separated from the fæces with little contamination.

Specimens of all species of mollusc found were placed in water swarming with Miracidia, and a watch was kept to see whether any of them showed any special attraction for the embryos. One form, named from the locality in which it abounded, *Katayama nosophora*, speedily became festooned on head and feet with white specks, which obviously caused great irritation. In many individuals of this species the liver was found ramified with fine tubes (sporocysts) containing cercariæ with bifid tails, and with the complete absence of pharynx characteristic of the schistosome larva. The livers of infected snails were teased out, and the cercariæ allowed to become free and swim about. Live mice were

* Brit. Med. Journ., 1915, pp. 1–16 (10 figs.).

then immersed in the water. The outbreak of war put an abrupt end to the work, and many of the mice died at sea too soon to show any result. One mouse, however, infected at Aden from the remaining living molluscs, was safely brought to London. Live male and female schistosomes *in copulâ* were found in the portal veins, and a permanent preparation was made. The results confirmed those of Miyairi, who had shown earlier (in an inaccessible Japanese paper) for *S. japonicum* that one or more species of water-snail act as intermediate host of the parasite.

To the paper is appended a description, by G. C. Robson, of the snail used in the experiment. Though very abundant in some localities, it is apparently a hitherto undescribed species.

Structure of a New Tapeworm.*—T. Harvey Johnston gives an account of *Ophiotænia longmani* sp. n., from a Queensland python (*Aspidiotes ramsayi*). He describes the very thin cuticle, the cortical calcareous bodies, the strong anterior muscles, and so on. The author also reports from a coypu the bladderworm *Cœnurus serialis*, or, better, *Multiceps serialis*, not uncommon in rabbits. Tiny cestodes of the genus *Nematotænia* were got from New South Wales frogs, and some other parasites are recorded.

Incertæ Sedis.

Sex in Dinophilus.† — Paul de Beauchamp finds that the large opaque ova of this aberrant type may sometimes develop into males. These are abnormal, but they produce spermatozoa. It has hitherto been believed that the large ova gave rise to females only, and that the small transparent ova gave rise to all the males. It can no longer be said that the sex of *Dinophilus* is absolutely dependent on the size of the ovum and the relative amount of yolk which is usually (not always) correlative with the size.

Echinoderma.

Development of Asteroids.‡—J. F. Gemmill deals first with *Asterias glacialis*. A small solid outgrowth from the stomach-wall is found in nearly all the early larvæ, and a brood occurred in which this outgrowth was larger, developed a central cavity, and fused with the backward-growing cœlomic cavity of the left side. It is interpreted as a rudimentary posterior enterocœlic outgrowth. In *Cribella oculata* it is shown that the perihæmal pouch belonging to the madreporic interradius arises from the dorsal horn of the left posterior cœlom ; that the aboral skeleton arises in the form of scattered plates without definite radial and interradial arrangement ; and that the terminals are formed by fusion of several of these plates.

The author's previous description of *Solaster endeca* is supplemented in various points : all the perihæmal pouches arise from the posterior

* Mem. Queensland Museum, v. (1916) pp. 186–96 (16 figs.).
† Comptes Rendus, clxiv. (1917) pp. 56–8.
‡ Proc. Zool. Soc., 1916, pp. 553–65 (2 pls.).

cœlom; there are outgrowths from the posterior cœlom to form the preoral cœlom in all the interradii; closure of the hydrocœle-ring takes place in interradius VIII–IX; the mouth-angle plates and interior processes of the first ambulacrals arise as single continuous calcifications. The early development of *Stichaster roseus* resembles that of *Asterias rubens*, and it is inferred as almost certain that the final larval form will prove to be a brachiolaria attaching itself at metamorphosis.

Early Development of Cucumaria.*— H. G. Newth finds that the larval life of this Holothurian is very short as compared with that of the Auricularia. It takes place at the expense of the yolk, and is complete in about five days. Formation of the cœlomic vesicles occurs by the bending and constriction of the archenteron. No separate anterior cœlom appears. The hydrocœl ring closes in the left dorsal interradius, and the radial canals and five primary oral tentacles arise directly from it, alternating with one another. The internal madreporite arises as a secondary differentiation of the walls of the stone-canal.

Action of Oxazine on Germ-cells of Sea-urchin.† — M. Herlant recalls the observations of Werbitzki, Laveran, and Roudsky that oxazine (chloride of triaminophenaroxonium) destroys the centrosome of Trypanosomes without altering their vitality. The power of moving and dividing persists, and the modification is transmitted. Herlant has tried the effect of oxazine on ova and spermatozoa of *Paracentrotus lividus*; a few drops (1–25) of a solution of one part of oxazine to a thousand of distilled water were added to the sea-water (25 c.c.) containing the germ-cells. The development of larvæ from eggs fertilized with poisoned spermatozoa is sometimes abnormal, but the effect on the spermatozoa seems curiously individual. The stronger doses of oxazine proved fatal. There was no evidence of an elective or destructive action on the sperm-centrosome. A dose of 4–5 drops proved favourable to ripe egg, preserving them from cytolysis and prolonging their life. The fertilized ova seemed to be unaffected.

Cœlentera.

Genus Kirchenpaueria.‡ — M. Bedot has made a study of the definition of this genus. It is distinguished from *Plumularia* as follows: it has not, on the hydrocladus, nematophores disposed in pairs; below and behind the hydrothecæ there is a nematophore not surrounded by a nematotheca; the nematophore in front of the hydrotheca is surrounded by a monothalamic nematotheca, fixed by a broad base and immobile; the gonotheca are attached along the stem. The genus is represented by *K. pinnata*, and the other species which Bale referred to it may be ranked at present in the genus *Diplocheilus*, which is marked by close, not crowded, hydrothecæ, by the absence of

* Proc. Zool. Soc. London, 1916, pp. 631–41 (2 pls. and 1 fig.).
† Arch. Zool. Expér., lv. (1916) Notes et Revue, No. 3, pp. 48–52.
‡ Rev. Suisse Zool., xxiv. (1916) pp. 637–48.

intermediary joints, and by the position of the nematotheca, close to, not at a distance from, the base of the hydrotheca.

Northern Hydroids.*—Hjalmar Broch proposes to give detailed diagnoses of all the species collected by the Ingolf Expedition, which furnished copious material. The characteristics of the nutritive polyps are of much greater systematic value than those of the gonophores or the medusoids. An account is given of the minute structure of a typical polyp, and then follows a key of athecate hydroids. The author then gives an account of the Corynidæ (*Coryne*), Myriothelidæ (*Myriothela*), Tubulariidæ (*Tubularia*, *Corymorpha*, *Clava*, *Merona*, *Monobrachium*), Bougainvilliidæ (*Hydractinia*, *Bougainvillia*, *Perigonimus*, and *Eudendrium*).

New Genus of Trachomedusæ.†—H. M. Bigelow describes *Eperetmus typus* g. et sp. n., from off southern Alaska. It is one of the Olindiidæ, with four metameres; with primary tentacles only, and in a single series; with centripetal canals; and with the otocyst capsules deeply imbedded in and entirely enclosed by the gelatinous substance of the bell.

Development of Alcyonium digitatum.‡—Annie Matthews finds that the fertilized ova of this common Alcyonarian segment in various ways, but typical morulæ always result. When the 16-cell stage again divides to form the 32-celled embryo, delamination occurs, and the larva becomes two-layered. The morula at the twentieth hour begins to undergo a series of contortions, which last till the third day. This solid contorted stage is termed the pre-planula, as it passes on into the hollow planula stage.

The pear-shaped planula, while swimming, exhibits characteristic "planarian-like" movements, and on the fourth free-swimming day (the seventh day of development) it settles down by the broad anterior and aboral pole.

The settled larva soon flattens, assuming a mound-like shape, and on the second day of fixation eight mesenteries grow out simultaneously into the cœlenteron from the base of the lateral wall. The cœlenteron is identical with the hollow central space in the endoderm of the planula. The mesenteries, arranged in four distinct pairs, grow simultaneously and rapidly along the lateral walls and attached base, and soon nearly meet on the basal and oral surfaces of the polyp. Many round cells now appear at the base of columnar ectoderm. Mesoglœa is at this time secreted by the endoderm, and flows round the above-mentioned ectoderm cells, cutting them off either singly or in groups. These isolated ectoderm cells produce either nematocysts or spicules, the spicules appearing soon after the mesenteries.

Early on the third day eight simple hollow tentacles grow out, alternating with the mesenteries, and encircling the oral surface. Later on the third day the stomodæum and mouth arise by the appearance of a rapidly deepening invagination of the oral surface in the centre of

* Danish Ingolf Expedition, v. (1916) No. 6, pp. 1–66 (2 pls. and 20 figs.).
† Proc. U.S. Nat. Museum, xlviii. (1916) pp. 397–404 (1 pl.).
‡ Quart. Journ. Micr. Sci., lxii. (1916) pp. 43–94 (3 pls. and 51 figs.).

the circle of tentacles. Yolky detritus is still present in the cœlenteron. On the fourth day the base of this invagination degenerates, and so the cœlenteron communicates with the exterior.

While the mouth invagination is still in process of formation, the endodermic portion of the mesenteric filaments arises on the six ventral mesenteries by a proliferation of cells on the upper part of the free edge. On the fifth day the ventral mesenteric filaments are completed by strap-like ectodermic down-growths from the stomodæum over the endodermic thickening on each mesentery. On the sixth day the dorsal mesenteric filaments arise. The dorsal and ventral mesenteric filaments appear homogeneous in origin, though of diverse function. On the seventh day the eight filaments reach about half-way down the free edges of their respective mesenteries.

Further development consists of elaboration of the organs already present. At the end of the third week the first bud is formed, and the solitary polyp becomes a young colony by stolonial gemmation. The young colonies were successfully fed in the laboratory on larvæ and adult individuals from colonies of *Leptoclinum* and *Botryllus*.

Monograph on Pennatulacea.*—Sydney J. Hickson has completed a magnificent monograph, dealing with the Pennatulacea of the Siboga Expedition—the richest collection of sea-pens that has ever been made by a single scientific expedition. Seventeen genera and forty-five species are represented. Many anatomical and histological descriptions are given, and attention may be directed to the investigation of the structure and distribution of the radial canals in *Virgularia*, *Anthoptilum*, and *Osteocella*; of the structure of the "mesozooids" of *Pennatula murrayi*; and of the structure and relations of the remarkable brown tubes of the same species. Mesozooids have been found only in a few Pennatulids; they differ from autozooids and siphonozooids, and appear to be exhalant in function. They have no tentacles, mesenteric filaments, or gonads.

The "brown tubes" form a series of bent tubes lined by a specialized epithelium, forming a means of communication between the subcutaneous system of endodermal canals (the "solenia") and the lateral longitudinal canals. In unstained sections they are brown. The epithelium lining the tubes is columnar and undoubtedly ciliated. At each end of the tube there is what appears to be a tumid rosette-shaped funnel mouth on which the cilia are usually well preserved. These funnels recall nephrostomes. It may be that the brown tubes bring the mesozooids into relation with the dorsal longitudinal canal.

The gonads of many species were examined, and the general results arrived at are (1) that all the species are diœcious, (2) that all the species are oviparous, and (3) that the sexual organs may reach maturity long before the full size of the colony is attained. No evidence was found of protandry or protogyny, nor a single case of an egg that has begun to segment within the body-cavity of the parent. There is an interesting discussion of the evolution of the Pennatulacea.

* Siboga-Expeditie, Monograph xiv. Leiden: 1916, x and 255 pp. (1 chart 10 pls., and 45 figs.).

Protozoa.

Studies of Protists.*—G. Trégoudoff has studied at Villefranche a new mouthless ciliate, *Perezella pneumodermopsidis* sp. n., a parasite in the general cavity of *Pneumodermopsis ciliatum*, a gymnosomatous Pteropod. The cilia are in fourteen rows, each arising from a basilar corpuscle; the contractile vacuole is always posterior; the macronucleus divides by constriction; the micronucleus divides into two parts connected for some time by a long band. The author discusses the Acinetarian *Trichophrya salparum* Entz; a new species, *T. morchellii*, from *Morchellium*; and a new sub-species, *T. salparum*, *pyrosomæ* from *Pyrosoma*. In a species of *Porospora* from *Pisa gibsi*, almost 1 mm. in length, solitary encystation was observed, and also a peculiar conjugation preceding encystation. One of the conjugates fixes its anterior end into the body of the other, which is more passive.

Infusorians of Lake Geneva.†—Emile André has been able to add thirty-three species to the known list of 111 species of Infusorians from this lake. Four of the thirty-three are new records for Switzerland, and three are new to science—viz. *Holophrya haplostoma* sp. n., marked, like *H. ovum*, by a very simple mouth; *Nassula versicolor* sp. n., with diverse coloration due to pigment, chlorellæ, and food particles; and *Prosopsenus sinuatus* g. et sp. n., in the family Oxytrichinæ and sub-family Psilotrichinæ. In the last form the cirri are all in the posterior half except four on the frontal region, and the peristome extends for three-quarters of the length of the animal.

New Genus of Coccidia.‡—L. Léger and O. Duboscq describe *Pseudoklossia glomerata* g. et sp. n., from the kidneys of the bivalve *Tapes*. They occur as intracellular parasites, and cause hypertrophy of the nucleus of the cell. When the infestation is intense there may be five to ten coccidia pressed together, as the specific name *glomerata* suggests. Gamogony occurs, and the development of microgamete and macrogamete is described in detail. Schizogony was not seen with certainty. The nearest relationships of the new genus seems to be with *Aggregata*, from Cephalopods, and with *Angeiocystis* and *Caryotropha* from Annelids.

Studies on Gregarines.§—Minnie Elizabeth Watson describes twenty-one new species of Gregarines, gives a synopsis of the Eugregarine records from the Myriopods, Coleoptera, and Orthoptera of the world, discusses the structure of typical Stenophoridæ and Gregarinidæ, and deals with various questions relating to the life of these parasites.

Gregarines infect only Invertebrates. The only Invertebrates from which they have not been recorded are Protoza, Porifera, and Rotifera. The mid-intestine is the chief area of infection with the sporonts, which

* Arch. Zool. Expér., lv. (1916) Notes et Revue, No. 3, pp. 35–47 (4 figs.).
† Rev. Suisse Zool., xxiv. (1916) pp. 621–34 (1 pl.).
‡ Arch. Zool. Expér., lv. (1915) Notes et Revue, No. 1, pp. 7–16 (4 figs.).
§ Illinois Biol. Monographs, ii. (1916) pp. 1–258 (15 pls.).

usually lie close to the epithelial walls. There is absorption of food through the epimerite as well as by the general surface.

Normal salt solution is the best artificial medium in which to study the movements of Gregarines. Locomotion is effected by means of a progressive, gliding movement, with no apparent localized motion of the body. In *Leidyana erratica* progression takes place at the average rate of 0·8 micron per second. In artificial media there are formed gelatinous threads at the posterior end of the deutomerite. These threads do not occur in a freshly-made mount; they may be seen with a high power and a minimum amount of light in a mount which has been made for some time; they may be demonstrated with carmin particles in suspension.

The animal probably moves by imperceptible vertical movements of the myonemes of the side which is ventral at the time, and upon a surface whose friction is caused by an exudation of slime from the body of the parasite. This mucus is secreted by the body and exudes through pores between the longitudinal ridges in the epicyte or delicate external ectoplasm. The mucus passes backwards along the longitudinal ridges to the posterior end, and is discharged as a waste product in the form of broken threads or strands. The anterior half of the deutomerite is the region chiefly involved in bending movement. The protomerite is incapable of independent bending movement. The normal object of contortion is the formation of cysts.

Evolution among Protozoa.*—R. D. Greenaway discusses some structures the evolution of which cannot, he thinks, be readily interpreted in terms of Natural Selection. The Thecolobosa like *Difflugia* and *Arcella* live along with naked Amœbæ which are more numerous than they; poly-flagellates live in the same conditions of life as mono-flagellates; the highly specialized Ciliata live side by side with flagellates (which, being less "fit," should on the Selection Theory, as conceived by the author, have become extinct long since). Similarly, extremely minute and the relative gigantic Ciliata, *Bodo* and *Trachelius*, rub shoulders in every environment; the excellence of the springing apparatus in *Halteria*, or the trophic cilia of *Bursaria*, or the setose processes of *Euplotes*, have arisen without any sign of extinction on the part of less well-endowed neighbours. It is the recorder's task simply to illustrate the point of Mr. Greenaway's criticism, but it should be noted that the difficulty raised was familiar to Darwin, and arises from an inadequate conception of the theory of Natural Selection.

* Zoologist, xx. (1916) pp. 303–11.

BOTANY.

GENERAL,

Including the Anatomy and Physiology of Seed Plants.

Cytology,

Including Cell-Contents.

Origin of Chromoplasts and Pigment-formation.* — A. Guilliermond publishes the results of his investigations concerning the origin of chromoplasts and the formation of pigments belonging to the xanthophyll and carotin groups. The pigments appear to be formed in three different ways :—1. A diffuse or finely-granular pigment is formed within the mitochondrias or the chromoplasts arising from the mitochondrias. 2. The pigment formed within the mitochondrias or chromoplasts is at first diffuse or granular, but afterwards becomes crystalline. 3. The chloroplasts formed from the mitochondrias enlarge considerably, and give rise to diffuse, granular, or crystalline pigments. The third method is characteristic of the mesocarp and mesophyll of the majority of fruits and flowers. This mitochondrial origin explains the elongated form of all the simplest chromoplasts, which are, in fact, chondriocontes. Finally, it is of interest to note that pigment-formation in plants is effected by a process similar to that which has recently been observed in animals.

Structure and Development.

Vegetative.

Epidermal Cells of Roots.†—Edith A. Roberts gives a summary of work by previous observers on the factors governing the development of root-hairs, and also the results of her own investigations. The plants studied included barley, maize, lettuce, sunflower, and several species of Cruciferæ. The writer finds that the initial formation of the root-hair is indicated by a general swelling of the outer wall of the epidermal cell. The swelling is produced if the physical resistance of the wall is overbalanced by the higher osmotic pressure which is maintained on the inside of the wall ; further swelling followed by growth takes place at the less resistant portion of the wall. This region bears no relation to the position of the nucleus. The wall of the root-hair is composed of two parts, an inner membrane of cellulose and an outer membrane of

* Comptes Rendus, clxiv. (1917) pp. 232–5.
† Bot. Gaz., lxii. (1916) pp. 488–506 (17 figs.).

calcium pectate. The presence of this membrane, together with the fact that the soil particles are held to it by a pectin mucilage, accounts for the high efficiency of the root-hair as an absorbing organ.

Concentric Xylem in Dicotyledons.*—J. Daniel publishes a series of papers dealing with the concentric layers of secondary xylem in Dicotyledons. The following are the chief conclusions:—There is a close connexion between the conditions of life, the rhythmic development, the organography, and the structure of the secondary wood in Dicotyledons. External morphological differences often correspond to internal difference in the structure of the xylem, and usually result from the same cause. Modes of branching, difference in food-supply, position and time of appearance of the different organs, etc., react upon the xylem structure and symmetry; it is often possible to foretell such alterations in structure, and even to produce them artificially. Herbaceous plants of rosette habit have characteristic xylem resulting from peculiarity of physiological conditions, but having no connexion with the age of the plant. In trees the relation between the age and the number of concentric layers of wood can be traced for a short time in the short branches, and for a longer time in the main branches and trunk, but after a certain time it becomes impossible to trace any such relationship even with the aid of a Microscope. It is possible to increase or decrease the number of concentric xylem rings by artificial means; in nature this may occur accidentally. It is not possible to determine the age of a herbaceous plant by examining transverse sections of its root or stem; it is only possible to do so with trees during a regular and active period of growth, and when it is certain that there has been no violent disturbing factor; when the old trees have been felled it is impossible to determine their age. The author claims that as his results are based upon experience and fact, not upon hypotheses, they may be of practical use to the gardener, the agriculturalist, and the cultivator of trees.

Reproductive.

Embryo-sac Development.†—P. Baranow has studied the development of the embryo-sac in *Spiranthes australis* and *Serapias pseudocordigera*. In *Spiranthes* the numerous ovular filaments are composed of single rows of similar sub-epidermal cells. At an early stage the apical cell begins to enlarge, and ultimately becomes the mother-cell of the embryo-sac. Division of the nucleus is succeeded by division of the cell itself into two daughter-cells; the nucleus of each of these cells contains only half the number of chromosomes found in the mother-cell. The upper daughter-cell soon perishes, while the lower one greatly enlarges and again divides, the nuclear division being homotypic in character; in this case also the upper daughter-cell perishes, while the lower cell forms the mother-cell of the embryo-sac. Simultaneously with these

* Rev. Gén. Bot., xxviii. (1916) pp. 97–115, 133–49, 185–92, 204–20 (8 pls. and 63 figs.).

† Bull. Soc. Impér. Nat. (Moscow), xxix. (1915) pp. 74–92 (29 figs.).

changes, two integuments are being formed. The embryo-sac nucleus divides twice, giving rise to four nuclei, which lie in pairs at each pole of the cell. The two at the micropylar end again divide, but those at the chalazal end usually remain undivided, and form, together with the other four, the six nuclei of the embryo-sac. Three of the micropylar nuclei form the synergidæ and oosphere, while the fourth passes to the centre and fuses with one of the nuclei from the chalazal end to form the secondary nucleus; the remaining nucleus (or nuclei rarely) at the chalazal end forms a simple autipodal nucleus. Of the two male-cells which enter the embryo-sac, one fuses with the oosphere and the other with the secondary nucleus. As a result of fertilization, the oosphere immediately enlarges, and develops into the embryo, while the fertilized secondary nucleus perishes without forming any albumen (endosperm).

In *Serapias* the first stages of development are practically identical with those described above, but whereas in *Spiranthes* the embryo-sac is sometimes found to have eight nuclei, in *Serapias* the number is invariably six. The polar nuclei also have a more interesting development; sometimes they come into contact without fusing, while at other times the upper polar nucleus travels down to meet the lower one, and remains in contact both with the latter and with the antipodal. When the second male-cell enters the embryo-sac it passes towards the polar nuclei, and ultimately the group fuses, although it is not rare to find groups where fusion never occurs. In either case they soon perish, without having formed any endosperm. The author concludes that the typical Orchid had originally four macrospores, but that the four may be reduced to three in the manner described above; corresponding with this condition, the embryo-sac of the type contains eight nuclei, but the simpler and more recent type contains only six. In *Spiranthes australis* an intermediate stage is seen, since the embryo-sac has sometimes eight, but at other times six nuclei.

In the greater number of the Orchidaceæ the formation of the secondary nucleus is of great interest. It is usually formed by the fusion of the two polar nuclei and one male-cell. In *Cypripedium* it results from the fusion of a synergid, a polar nucleus, and a male-cell. In those species which have six nuclei in the embryo-sac it frequently results from the fusion of two polar nuclei, an antipodal and a male-cell. Usually no endosperm is formed, but in *Cypripedium* four daughter-nuclei are formed and then disintegrate. The suspensor varies from a series of two dozen cells to a considerably reduced series, or it may even be represented by a single cell.

Structure of Pepper.* — T. E. Wallis publishes a description of some hitherto unnoticed tissues which occur in the berry of white pepper, and which when crushed give the appearance of adulteration in pure samples. At the apex of the berry is a conical depression resting immediately upon the cavity containing the embryo and endosperm. In this region the pericarp is modified. The sclerenchyma is more

* Analyst, May, 1915, pp. 1–8 (5 figs.).

lightly built; the middle layer of the pericarp, which elsewhere is composed of thin-walled, irregularly polygonal cells, is reduced to a single layer of rectangular cells with very thick, sparsely pitted walls; the pigment layer, which is usually composed of flat, rectangular cells with dark brown contents, is here formed of regular polygonal cells with thickened walls; the hyaline layer is wavy in appearance, owing to the cell-walls being thrown into folds.

The conical projection at the base is due to the entry at this point of the fibro-vascular bundles, which pass thence over the surface of the berry towards the apex. In this region the pigment layer is of greater thickness and is composed of small, slightly compressed cells; the inner sclerenchyma and the layer beneath it, together with the hyaline layer, all disappear. These modified tissues of the apex and base may easily be mistaken for foreign matter in crushed berries.

CRYPTOGAMS.

Pteridophyta.

(By A. Gepp, M.A. F.L.S.)

Anatomy of Leaf in Osmundaceæ.*—D. T. Gwynne-Vaughan's paper, "Observations on the Anatomy of the Leaf in the Osmundaceæ," is published posthumously, and substantially without alteration, save by the provision of photographic illustrations. After giving a résumé of the views published by R. Kidston and himself in a series of papers on the origin and evolution of the typical adaxially curved leaf-trace in the Filicineæ, and on the fossil Osmundaceæ, he proceeds to investigate the C-shaped leaf-trace of the living Osmundaceæ in search of any indications of the primitive method of branching. Among the species studied were *Osmunda Claytoniana*, *O. regalis*, *O. bipinnata*, *Todea superba*, *T. barbara*, *T. hymenophylloides*. He finds evidence that in the xylem strand of the petiolar trace in the neighbourhood of the smaller branchings we have to deal with three distinct regions:—1. The abaxial curve of the xylem strand. 2. A lateral portion which is going to pass out into the branch. 3. A mass of centripetal xylem that is going to remain in the mother trace. This, says the author, makes a line drawn across the adaxial points of departure of the branch-traces a very important distinction, because it divides the parent trace into portions corresponding to the abaxial (centrifugal) and adaxial (centripetal) halves of the presumed ancestral trace. In the larger trace these regions are still present, all enlarged, but unequally so. The greatest extension is experienced by the abaxial curve, but the centripetal xylem also increases in volume and may acquire a protoxylem or even two of its own.

Climbing Davallias and the Petiole of Lygodium.†—D. T. Gwynne-Vaughan's notes on some climbing Davallias and the petiole of *Lygodium*,

* Ann. Bot., xxx. (1916) pp. 487–93 (1 pl.).
† Ann. Bot., xxx. (1916) pp. 495–507 (1 pl.).

together with his pencil sketches and photographs of microtome sections, are published posthumously. The species studied were *Lygodium scandens*, *L. japonicum*, *L. dichotomum*, *L. volubile*, *Davallia fumarioides*. The summary supplied by the editors states:—1. Bertrand and Cornaille's interpretation of the petiolar trace of *Lygodium*, as derived by the union of the inverse folds of the metaxylem of a C-shaped trace, is confirmed. 2. In *Lygodium japonicum* the dorsal protoxylem of the petiolar trace, consisting of annular or spiral elements, is not exarch but mesarch, being more or less completely enclosed by centrifugal metaxylem. 3. In the petiolar trace and branch-traces of *Davallia fumarioides* all stages between the open C-shaped trace and the condition present in *Lygodium* are found. 4. In this condensation of the C-shaped trace of *Davallia fumarioides* the adaxial hooks of xylem completely disappear. It may be inferred that they are absent in the trace of *Lygodium* also.

Prothallus of Phylloglossum.*—K. Sampson gives an account of a young sporeling of *Phylloglossum* attached to a prothallus, and possessing a single leaf 8 mm. long, a slender root and a small storage tuber. The prothallus, about 2 mm. diameter, was of a relatively unspecialized type, and its notable feature was the presence of fungal hyphæ. The hyphæ were of two sorts: 1. Coarse, non-septate, probably saprophytic, hyphæ among the outer layers. 2. Slender, septate and frequently coiled hyphæ, abundant and endophytic in the central region of the prothallus. Some traces of an immature antheridium (?) were found. As regards that part of the sporeling which was found in contact with the prothallus—the embryonic swelling—it remains an open question whether it be a foot or a protocorm; but the presence of both an embryonic swelling and a characteristic storage tuber indicates that *Phylloglossum* falls into line with one or other of the Lycopodian series possessing an embryonic swelling (*Lycopodium clavatum* or *L. cernuum*), and that the annual storage tuber is of entirely independent origin.

Bryophyta.

(By A. Gepp.)

Mnium antiquorum.†—H. N. Dixon gives an account of *Mnium antiquorum*, an extinct moss found by the late Clement Reid among plant-remains obtained from the Pliocene deposits at Reuver, in the valley of the Maas on the border-line between Limburg and Prussia. These plant-remains show a remarkable affinity with the present flora of China and Japan. Fragments of two mosses were separated out, one closely related to *Porotrichum alopecuroides*, an East Asiatic species with an intra-marginal leaf-border; and the other belonging to *Mnium* sect. *Trachycystis*, and constituting a new species, *M. antiquorum* Card. and Dixon, the only allies of which are confined to East Asia. The structure of the leaves is figured.

* Ann. Bot., xxx. (1916) pp. 605–7 (figs.).
† Bryologist, xix. (1916) pp. 51–2 (figs.).

Drepanolejeunea bidens.*—Caroline C. Haynes publishes an account of *Drepanolejeunea bidens* (Steph.) Evans, a minute hepatic discovered on bark or leaves in Tennessee years ago by A. Ruth, but only recently determined by A. W. Evans. Previously the species was known only from tropical America. A. W. Evans's detailed description of the species is given in full, and figures of the structure are added. The plant is closely related to the British *D. hamatifolia*, which is also recorded from tropical America.

Bryological Notes.†—H. N. Dixon continues his series of notes on bryological difficulties. 1. He shows from Mitten's own writings that *Meteorium lanosum* Mitt. is conspecific with *M. longissimum* Doz. & Molk.; and that ingenuity of the later writers to prove them different in point of structure is wasted. 2. He revises H. Boswell's list of New Zealand bryophytes (1894). 3. *Lepidopilum sumatranum* v. d. Bosch & Lac. is not distinct from, but identical with *Hookeria utacamundiana* Mont. (*Lepidopilum* Mitt.). 4. The combination *Barbula rubella* (Hoffm.) is traced to S. O. Lindberg,‡ though it has wrongly been ascribed to Mitten. 5. *Dicranum dichotomum* (Bourbon), *D. Billardieri* (sub-antarctic), *D. commutatum* and *D. tabulare* (Cape of Good Hope), *D. scopareolum* and *D. patentifolium* (Madagascar) are proved to be conspecific. 6. A similar clearing up of the synonymy of two Australasian species, *Cryphidium ovalifolium* and *C. dilatatum*, is made. The structural details upon which these notes are based are clearly defined in the original paper.

Hepatics in West Cornwall.§—W. E. Nicholson publishes a list of some interesting hepatics gathered at the Lizard and Carbis Bay during a brief visit in the spring of 1916. Two of these, *Fossombronia Crozalsii* and *Dichiton calyculatum*, had not previously been recorded for this country; and it may be that the rarity of *Dichiton* is partly due to the superficial resemblance of the plant to *Cephaloziella integerrima*, *Lophozia excisa*, etc. A full description of *Dichiton* is given; and critical notes on the structure of some of the other species are supplied.

Thallophyta.

Algæ.

(By Mrs. Ethel S. Gepp.)

August Heleoplankton of some North Worcestershire Pools.‖—B. M. Griffiths reports on collections of heleoplankton taken from nine pools in the Kidderminster district. Marked peculiarities are shown in the respective floras. In many cases, also, species either rare or not commonly found in the plankton of large lakes were present. The pools were too small to allow of true plankton being found. A large number

* Bryologist, xix. (1916) pp. 83-6 (figs.).
† Journ. Bot., liv. (1916) pp. 352–9.
‡ Mus. Scand., 1879, p. 22.
§ Journ. Bot., lv. (1917) pp. 10–12.
‖ Journ. Linn. Soc., xliii. (1916) pp. 423–32 (2 pls.).

of forms are derived from the benthos. The pools were either (1) traversed by a considerable stream; (2) supplied by bottom springs or by small streams from adjacent springs; or (3) supplied by overflow from the river Stour. An analysis of the collections is set forth in tabular form. The following points of interest are emphasized:—1. The presence of Bacillarieæ other than *Asterionella* is probably due to the occurrence of weeds, through which the plankton-net was unavoidably drawn. 2. The presence of *Pandorina* and *Eudorina* in the plankton appears to be correlated with comparative purity of water. 3. The presence of *Microcystis æruginosa* and other Myxophyceæ seems to indicate contamination. It occurred abundantly in those pools which were exposed to contamination from a village or from house-drainage. Another contaminated pool contained enormous quantities of *Aphanizomenon Flos-aquæ*. 4. Two of the pools had a predominant Protococcales flora. One of these is supplied by springs, and the other is derived from the River Stour. The latter contained *Crucigenia remiformis*, *C. apiculata*, *Scenedesmus Raciborskii*, and *Dictyosphærium pulchellum*. 5. Peridinieæ occurred in two of the pools, where there was but slight contamination.

A noteworthy feature was the number of algæ that was either very rare or not commonly found, such as *Microcystis ochracea* Forti, *Pteromonas aculeata* Lemm., *Scenedesmus Raciborskii* Wolos., *Oocystis parva* W. & G. S. West, *Crucigenia apiculata* Schmidle, *Tetrastrum staurogeniæforme* Chodat, *Geminella interrupta* Turpin, *Ceratium Hirundinella* Schrank. Two new species are described.

French Peridinieæ.*—J. Pavillard publishes the result of his researches on the Peridinieæ of the Gulf of Lions, which includes a systematic list of the Peridinieæ collected by himself. To most of the species notes are appended on their morphology or geographical distribution. Eleven new species, one new genus (*Pachydinium*), and some new varieties are described.

Swedish Plankton-algæ.†—E. Teiling continues his studies of Swedish plankton, and in the present contribution describes a new genus of Protococcoideæ which he calls *Tetrallantos*. It is most closely allied to *Dimorphococcus*, and has affinities with *Schmidleia* and *Schrœderella*. It was found in a pond of over 1 m. in depth in the vicinity of Skara, a town in Gotland. Here the author collected an abundant material of plankton in the summer of 1915, consisting almost entirely of Protococcoideæ, Desmidiaceæ, and Flagellatæ. Species and varieties new to Sweden are recorded, as well as the novelties *Tetrallantos Lagerheimii* and *Trachelomonas Hystrix*.

Phytoplankton from the Indian Ocean.‡—G. B. de Toni and A. Forti report on a collection of phytoplankton collected by the

* Trav. Inst. Bot. Univ. Montpellier et stat. zool. Cette, Mém. iv. (1916) 70 pp. (3 pls.). See also Nuov. Notar., xxviii. (1917) pp. 123–4.

† Svensk. Bot. Tidskr., x. (1916) pp. 59-66 (14 figs.). See also Nuov. Notar., xxviii. (1917) pp. 121–2.

‡ Mem. R. Istit. Veneto Sci. Lett. Art., xxix. No. 1 (1916) 33 pp. (3 pls. and figs. in text).

'Liguria' of the Italian navy. The collections were made in the Sea of Arafura, also between Bangkok and Saigon, and in the Gulf of Siam. The plankton of these regions has not been much explored, though occasionally records of diatoms and Peridinieæ from the Arafura Sea and Siam appear in literature. As regards the Arafura Sea *Catagnymene pelagica* Lemm. and *Thalassiothrix Frauenfeldii* var. *javanica* Grun. are new records. Many species are new for the Gulf of Siam, where the genera *Coscinodiscus* and *Rhizosolenia* constitute the predominant types. Forty-two species are recorded, with critical notes on morphology, systematic position, and geographical distribution. Under *Coscinodiscus Sol* Wall. the authors discuss the autonomy of the genus *Planktoniella* Schütt; *C. prætextus* of Janisch is described in detail; also *C. bipartitus* Rattr., of which the authors add to the diagnosis a description of a 5-sided individual.

Marine Diatoms from Iceland. —E. Oestrup reports on 438 samples of diatoms collected by various persons on the coasts of Iceland. The habitat and geographical distribution of each species are given, and in many cases notes on the morphology and affinity. Seven new species and some new varieties are described.

Diatoms of Philadelphia.†—C. S. Boyer publishes an account of the Diatomaceæ of Philadelphia and vicinity, which he hopes may lead to further research. In the introduction he shortly describes the geology of this district, which is included in the circumference of a circle, having a radius of one hundred miles from Philadelphia and containing the States of New Jersey and Delaware, parts of Pennsylvania and Maryland, and extending eastward to New York Bay and Long Island Sound as far as New Rochelle. The district therefore provides marine, fresh-water and fossil forms. After a few remarks on classification, the author discusses the morphology and development of the group —the cell, cell-division, reproduction, evolution of form, motion of diatoms, function. Then follows the systematic account, with a short diagnosis appended to each species, and occasionally critical remarks. Every species is figured and to the same scale, namely, 800 diameters. In an appendix the author deals fully with the collection and preparation of diatoms, fresh-water, marine, and fossil, with instructions as to staining, and the preparation of selected mounts. The plates contain 700 drawings by the author.

Swiss Desmids.‡—F. Ducellier publishes further additions to his catalogue of the Desmidiaceæ of Switzerland, collected from the basins of the Lake of Geneva and the Rhone Valley. He has also received material from Canton Valais and from localities in Eastern Switzerland. Many species and forms are added to the Swiss flora, and many of the records are accompanied by morphological and critical observations.

* Botany of Iceland, i. (1916) pp. 347–94 (1 pl.). See also Nuov. Notar., xxviii. (1917) p. 133.

† The Diatomaceæ of Philadelphia and Vicinity. Philadelphia: Lippincott (1916) 143 pp. (40 pls.).

‡ Contribution à l'étude de la flore desmidiologique de la Suisse. Genève: Georg et Cie, i. (1915) (1 pl. and figs. in text). See also Nuov. Notar., xxviii. (1917 pp. 122–3.

Oocystis and Eremosphæra.*—G. I. Playfair publishes a monograph of New South Wales species of *Oocystis* and *Eremosphæra*. He draws attention to the polymorphism of *Eremosphæra* and its connexion with *Oocystis*, and he gives new and original diagnoses and figures of as many as possible of the species and forms hitherto published of these two genera. He confirms the observations of Chodat on *E. viridis* concerning its polymorphism, and figures the *Glœocystis* type, the autospore and the chloroplasts. Four new varieties are proposed for *E. viridis*, var. *acuminata*, var. *ovalis*, var. *doliformis*, var. *nodosa*. For the genus *Oocystis* the author gives detailed accounts of the species and varieties, with novelties and new combinations.

Tuscan Algæ.†—G. Bargagli-Petrucci writes on the microscopic flora of the borax-region of Tuscany. The lower algæ are abundant and impart even to hot arid localities a green tint, in vivid contrast to the white, yellow and ochraceous mineral incrustations. Ten species are recorded, determined by A. Forti. They are *Glœocystis vesiculosa*, *Chlamydomonas* sp., *Dimorphococcus* sp., *Stichococcus variabilis*, *Hariotina* sp., *Polyedrium* sp., *Chromulina Rosanoffii*, *Hapalosiphon laminosus*, *Phormidium Valderianum*, *Nitzschia Palea*.

Phycoerythrin in Nostoc commune.‡—E. Teodoresco records the presence of genuine phycoerythrin in *Nostoc commune*. He refers in his paper to the work of Gaidukov, who noted the resemblance between the properties of the violet colouring matter of *Oscillaria sancta* and those of the red pigment of *Ceramium* and the violet or purple pigment of *Chondrus crispus*. The work of Bocat, however, supplied the stimulus to a research on the subject. That author extracted from *Oscillaria Cortiana* a pigment which he considered closely allied though not identical with true phycoerythrin. Teodoresco followed up Bocat's work by examining many fresh-water Cyanophyceæ. The only satisfactory experiment was that on *Nostoc commune*, material of which was collected in the month of June in the Botanical Garden at Bucharest. The plant had grown on a sunny slope covered with moss and grass, and was of a brownish or yellowish blue, not greenish blue as is usual. The pigment extracted from this material presented, after most careful examination, the same bands of absorption and relative intensity as those of phycoerythrin. The red pigment of *N. commune* is not a variety of phycocyanin, since it does not contain the most characteristic spectroscopic band which is common to the three sorts of phycocyanin.

New Laminaria for France (L. Lejolisii).§—C. Sauvageau describes how last September he discovered at Roscoff a strange species of *Laminaria*, which he calls provisionally *L. Lejolisii*. It was growing among *L. flexicaulis*, from which it was at once to be distinguished by

* Proc. Linn. Soc. N.S. Wales, xli. (1916) pp. 107–47 (3 pls. and 28 figs. in text). See also Nuov. Notar., xxviii. (1917) pp. 124–5.

† Nuov. Giorn. Bot. Ital., n.s. xxii. (1916) pp. 389–411. See also Nuov. Notar., xxviii. (1917) pp. 132–3.

‡ C.R. Acad. Sci. Paris, clxiii. (1916) pp. 62–4.

§ C.R. Acad. Sci. Paris, clxiii. (1916) pp. 714–16.

its pale frond. Certain of the stipites, which were broken off and had no haptera, exceeded 1 m. in length and had a basal diameter of 3–3·5 cm. The stipes is greyish-brown, quite smooth, very slippery, very flexible, without epiphytes, and contains muciferous canals arranged in two distinct rows in the young portion, one at the interior limit of the outer layer (*écorce*), the other outside the first and losing its distinct character in older portions of the stipes. At the base the intermediate layer of cells between the medulla and the outer cells comprises two concentric zones. The medulla, round or elliptic, sometimes slightly excentric, retracts sharply when exposed to the air and becomes white, like elder-pith. The whole decays rapidly in the air. All these characters are entirely opposed to those of *L. Cloustonii* with its rigid consistency. The outer layer of both species is rich in fucosan, fairly evenly distributed. In contrast to *L. flexicaulis*, the stipes is neither enlarged nor diminished at its extremity, and the cordiform base of the lamina widens suddenly; also it differs from *L. flexicaulis* in the outline of the medulla. The lamina of *L. Lejolisii*, about 1 m. long, provided with muciferous canals, is more transparent than those of other species of *Laminaria*; it is whitish, particularly at its undivided base. The segments, longer and less coriaceous than those of *L. Cloustonii*, bear large irregular sori corresponding more or less on both surfaces, and often partially destroyed by *Helcion pellucidum*. *L. Lejolisii* was found in three places growing with *L. Cloustonii*, and is certainly a new record for France. It is not a hybrid of *L. Cloustonii* and *L. flexicaulis*, but a distinct species, and approaches most nearly in exterior appearance to *L. pallida* Grev. That species is, however, incompletely known, and it is possible that the name has been applied to three distinct species, all of them different from the Roscoff plant. The appearance of *L. Lejolisii* at Roscoff is of recent occurrence and is a parallel case to that of *Colpomenia sinuosa*. If the deductions of Le Jolis relative to the concentric zones of *L. Cloustonii* are accurate, and if they apply to *L. Lejolisii*, the specimens collected would be two years old. The species can be propagated by zoospores, for the author has some growing under culture. It has also spread and multiplied at Roscoff. It was probably introduced by a ship or submarine and appears to be flourishing, in which it forms a contrast to *Alaria esculenta*, which after a whole century of existence on the French coast does not spread. The author points out that if the invasion of *L. Lejolisii* continues it will oust *L. Cloustonii*, which is very rich in iodine, but has less rapid growth.

Alternation of Generations in Laminaria digitata.*—H. Kylin publishes an account of his investigations on the germination of the zoospores of *Laminaria digitata* and the development of the young stages of the plant. These agree with the published researches of Sauvageau on the same alga. He describes his methods of culture, the germination of the zoospores, the male gametophyte, the female gametophyte, and the sporophyte, and gives figures of stages in their development.

* Svensk Bot. Tidskrift, x. (1916) pp. 551-61 (figs. in text).

Brown Seaweeds of the Salt Marsh.*—Sarah M. Baker and Maude H. Bohling have made an investigation of the brown seaweeds which form a conspicuous feature of some salt marshes, of their relation to the recognized systematic species, and of the effect of the physical conditions of the marsh upon the morphology of the plants. Of the common littoral Fucaceæ it is the following species to which the marsh forms are traced by the authors—*Pelvetia canaliculata*, *Fucus spiralis*, *F. vesiculosus*, *F. ceranoides*, *Ascophyllum nodosum* ; and to *F. vesiculosus* in particular are ascribed six of the forms. These ecological forms have been misunderstood by earlier writers or have been overlooked. They are derived from the rock-fixed recognized plants either by direct vegetative budding or by the modification of young plants germinating upon a salt marsh. Each individual species undergoes a series of striking morphological modifications in the transition from rock to salt marsh, and the adaptational varieties so produced are termed "ecads," and are persistent through many vegetative generations. The marsh ecads of the above five species, being all of the same general type, are grouped together under a "megecad *limicola*," including all the marsh-dwelling Fucoids as distinguished from those of saxicolous habit. The characteristics of the megecad *limicola* are briefly :—1. Vegetative reproduction. 2. Dwarf habit. 3. Absence of attachment disk. 4. Spirality or curling of the thallus. The methods of investigation employed by the authors show that dwarf habit is due to prolonged exposure to the air and diminished immersion in the water ; that curling or spirality is probably due to an unequal distribution of water and nutrient salts upon the thallus as it lies spread out on the intertidal mud ; that vegetative reproduction is probably favoured by the constant humidity of the intertidal mud, thus preventing that concentration of cell-sap which is essential as a stimulus for the production of receptacles and for the maturing of sexual organs. The authors add that "an examination of the famous floating Sargasso weed revealed the interesting fact that its peculiarities could be referred to the same physical factors as those of the marsh Fucoids—a confirmation of Börgesen's contention that it is produced and reproduced vegetatively from one of the saxicolous Sargassums."

Marine Algæ of the Island of Elba.†—G. B. de Toni publishes a list of the marine algæ recorded from the island of Elba, compiled mainly from the collections made by the Countess Vittoria Toscanelli, during the years between 1877 and 1882. The number of species recorded is 114. The list of algæ is preceded by the publication of the letters written by the Countess to Professor Ardissone on the subject of the algæ she found.

Algæ of the Gulf of Spezia.‡—A. Preda publishes the second contribution to his algological flora of the Gulf of Spezia, the first part of which appeared in "Malpighia," xviii. p. 76. The work was

* Journ. Linn. Soc., xliii. (1916) pp. 325–80 (3 pls. and figs.).
† Nuov. Notar., xxxii. (1917) pp. 1–58.
‡ Nuov. Notar., xxxii. (1917) pp. 59–69.

interrupted and is therefore incomplete, but is published in the hope of being useful to future students of the district. The number of species recorded is fifty-nine.

Algæ from Bengasi.*—G. B. de Toni and A. Forti issue a catalogue of fresh-water algæ collected in the region of Bengasi, in Tripoli, by Vito Zanon. Five of the species are new records for the African continent. Seventy-one species are recorded from Giuliana and thirty-two from Bengasi. Notes are appended to some of the records.

Oceanic Algology.†—A. Mazza continues his studies of marine algæ, giving descriptions of the structure of certain Squamariaceæ—*Rhododermis Van-Heurckii* and of three species of *Hildenbrandtia.* Passing on to the Corallinaceæ, he gives a scheme of the genera arranged in the form of a key, and then begins the description of their structure. In the present part he treats of *Schmitziella* (1 sp.), *Chætolithon* (1 sp.), *Epilithon* (1 sp.), *Sporolithon* (2 sp.), *Lithothamnion* (6 sp.).

Fungi.

(By A. Lorrain Smith, F.L.S.)

Origin of Spongospora.‡—G. R. Lyman and J. E. Rogers have collected information as to the country of origin of this potato disease. It is very wide-spread in Europe, and within the last three or four years it has appeared in the United States and in Canada.

It is considered to be a very old disease, as the union between host and parasite is extremely intimate, and the destruction of the host tissues very slow. Specimens of diseased potatoes have recently been discovered in Peru from the limits of potato production, where European materials could hardly have been present, and the supposition is that both host and parasite are indigenous in that locality. The disease there is not severe, and the spores are smaller than in European or American tubers.

Control of Chrysophlyctis endobiotica.§—E. Schaffint and G. Voss have been experimenting with measures to combat this disease in Germany. They give a list of the substances employed to destroy the fungus in the soil. None of them gave great satisfaction ; the best results were obtained with chromium acid carbonate. The experiments are to be repeated.

Many different varieties of potato were grown, and it was found that a number were immune from the disease ; others were slightly attacked, and yet others became very badly diseased.

The vitality of the spores in the soil also received attention. Potatoes were grown on soil that had been diseased in 1907 and has not

* Atti Real. Ist. Veneto Sci. Lett. Art., lxxvi. (1916). See also Nuov. Notar. xxviii. (1917) pp. 128–9.

† Nuov. Notar., xxviii. (1917) pp. 70–110.

‡ Science, xlii. (1916) pp. 960–41. See also Bull. Agric. Intell. Rome, vii. (1916 pp. 1033–4.

§ Zeitschr. Pflanzenkr., xxvi. (1016) pp. 183–92.

been cultivated since that date. Two plots of the field were used, and a very strong infection of the new potato plants was found on both plots, so the dormant spores must have retained their vitality in the soil for seven years. The operation is to be repeated in subsequent years on neighbouring plots.

Conditions of Development of Sclerotinia trifoliorum.*—Peglion Vittorio has traced the life-history of this fungus in relation to an outbreak of clover disease. On a plot of ground where the clover had succumbed to the disease he found many sclerotia in the soil, from which apothecia were developed towards the end of October and the beginning of November. He placed these in Petri dishes, and so secured the spores, which germinated freely and formed mycelium, and, subsequently, other sclerotia. Fragments of the mycelium from the gelatin cultures were transferred to a pot sowed with clover, lucerne, and fenugreek, and the young plants were destroyed as they appeared. The fungus had formed an inconspicuous network of mycelium over the soil, which surrounded the bases of the young stalks and destroyed them.

Fungi on Burnt Places.†—F. J. Seaver describes two such fungi collected in the outskirts of New York : *Peziza proteana*, a waxy white species changing slightly to lilac ; and *P. violacea*, pale violet, but becoming darker and finally almost black. Both are European species ; the former is recorded also from Texas, the latter from Wisconsin. It is not suggested that they may be imported species.

Fungus Spores in a Moss-capsule.‡—E. M. Dunham found these spores in a capsule of *Funaria hygrometrica* var. *patula* collected at Miami, Florida. The spores were 3-septate and ciliate at the ends, resembling those of *Pestalozzia*. This fungus is usually a leaf-blight, and forms its conidia beneath the epidermis. Though moss-capsules provide a favourable substratum for fungi, especially in moist warm regions such as Miami, E. M. Dunham considers that their occurrence in *Funaria hygrometrica* is rather remarkable, as it is an annual species, the capsule of which lasts but a short time.

Cylindrosporium on Stone-fruits.§—Bascombe Britt Higgins has made an interesting study of this shot-hole fungus. The fungus forms elongate colourless conidia on a more or less disk-shaped very thin stroma, just beneath the host-epidermis. When the conidia have accumulated in sufficient numbers, the epidermis is broken and the spores are squeezed out in long tendrils. The mycelium of the fungus is intercellular, with haustoria which penetrate the host-cells. These enter through a very small hole in the cell-wall, but the end swells out after entrance into an oval or elliptical body containing a nucleus and a

* Atti Reale Accad. Lincei, ser. 5, xxv. (1916) pp. 521–4. See also Bull. Agric. Intell. Rome, vii. (1916) pp. 1037–8.

† Mycologia, ix. (1917) p. 1–3 (1 pl.).

‡ Bryologist, xix. (1916) pp. 89–90 (1 fig.).

§ Amer. Journ. Bot., i. (1914) pp. 145–73 (4 pls.).

vacuole. A sheath of cellulose is often deposited by the host round the invading haustorium. The host-cells are not killed at first, except those in immediate contact with the "stroma," and their death is probably due to drying, and not to any toxic secretion by the fungus. Acervuli may be found on either surface of the leaf. Immediately below the layer of withered cells there is formed a series of much-enlarged cells. They are seen to have lost their chloroplastids and nuclei, and only a thin layer of protoplasm lines the wall. This is the separation layer, and just outside them another layer shrivels, forming additional protection to the healthy tissue.

It is suggested by the author that the swelling of these "separation" cells is due to increased osmotic pressure following on the breaking down of amygdalin molecules into simple molecules by an emulsion produced by the fungus.

The fungus passes the winter as a stroma-like body in or outside of the fallen leaves, and develops in early spring an ascigerous stage, *Coccomyces*. The various forms are discussed and described.

Uredineæ.—B. O. Dodge and J. F. Adams * present a study of *Cronartium* on *Myrica*, the *Peridermium* stage of which grows on pines. The chief experiments made were with the spores of *Æcidium myricatum*, with which *Chamæcyparis* was inoculated. Potted plants of the latter were kept in a greenhouse and sprayed with æcidiospores, but no results were obtained, though it has been proved by Fromme that *Æcidium myricatum* is connected with *Gymnosporangium Ellisii*. Descriptions are given of the various spores and of infection experiments.

A. H. Chivers † records an epidemic of rust on mint (*Puccinia Menthæ*) in gardens at Hanover, New Hampshire. The disease was first discovered about the middle of June, and by the middle of August the plants were unfit for use. The season was exceptionally wet, but with the improved weather the rust seemed to have disappeared.

Fungi of Virginia.‡—H. C. Beardslee describes several species of *Mycena* and *Omphalia* that occur at Ashville, and regarding which he is in some doubt owing to slight differences between them and European species. *Mycena stylobates* is pale grey rather than white; *M. iris* occurs in more than one form, all with more or less of blue mycelium; species of *Omphalia* are next described which differ from European species in more or less important particulars.

W. A. Murrill § gives a list of fungi collected in the Blue Ridge, north of Bedford, Virginia. The locality is described and the habitat of the various species. One lichen, *Gyrophora Muhlenbergii*, is recorded on rocks along the summit of the mountain. Black rock owes its name to this lichen.

Battarea phalloides in Britain.‖—This rare plant has reappeared in Britain, in a hollow tree at Temple Guiting, in Gloucestershire, and

* Mycologia, ix. (1917) pp. 23–9 (2 pls. and 2 figs.).
† Mycologia, ix. (1917) pp. 41–2.
‡ Mycologia, ix. (1917) pp. 30–3 (1 pl.).
§ Mycologia, ix. (1917) pp. 34–6.
‖ Journ. Bot., liv. (1916) pp. 105–7.

J. Ramsbottom takes occasion to describe it, and to give a sketch of its history in botanical literature. It was first described and figured by Thomas Woodward in 1784, from Bungay, Suffolk. Later it was found on sand-hills at Stoke, Norfolk. The next record is by H. H. Higgins, who found it in bare sand on the broken bank of a hedge near the top of the hill, New Brighton, in 1857. It has since been collected at Nork, near Epsom, and at Dropmore, Bucks.

Fungi of New Guinea.* — Under the title "Fungi papuani" H. and P. Sydow publish an account of the fungi collected in German New Guinea by Ledermann in 1912–13. Among Basidiomycetes the more woody genera, such as *Polyporus*, *Stereum*, etc., are best represented, and include several new species. Ascomycetes are more easily preserved, and are well represented with many new species. Two new genera of "Fungi imperfecti" have been established: *Sirosperma* (Sphæropsideæ), with minute pycnidia on a felted substratum, and parasitic on *Hypocrella* sp.; and *Sarophorum* (Hyphomycetes), with olivaceous catenulate spores borne on sterigmata which are produced at the ends of clavate hyphæ. There is one mycetozoon, *Arcyria denudata*, and one lichen, *Cora pavonia*, in the collection.

Mycological Notes.†—C. G. Lloyd gives with the present issue of his notes a short account of the work of Von Schweinitz, along with a portrait of this American fungologist. He was one of the pioneers of mycology both in America and in Europe, where he worked along with Albertini.

Lloyd has a series of notes on very varied fungi. He still receives and issues determinations and notes on *Cordyceps*. Along with *Cordyceps* he figures a new species of *Isaria* (*I. Buntingii*) from W. Africa found by R. H. Bunting on cocoons among fallen leaves. It is a very large species; the perfect *Cordyceps* has not yet been found. He has received from Australia a specimen of *Lycoperdon cruciatum* which is common in the United States, but evidently very rare in Australia. Among other unusual forms he figures pileate species of *Merulius lacrymans* from Canada. Such a form is quite new, but Lloyd has no doubt of the correctness of the determination. Most of the species dealt with are figured.

Black Spot of Chestnuts.‡ — B. Peyronel publishes a preliminary account of his investigations of this disease of chestnuts. Outwardly the chestnuts have the normal appearance, but when cut open the blackish brown colour of the internal tissues is apparent. Peglion had isolated a mycelium which he believes to be identical with *Rhacodium cellare*; it forms a black felt if the fruit is kept in moist conditions. The mycelium cultivated on artificial media has produced conidia of several different Hyphomycetes showing mixed infection. Bainier meanwhile had succeeded with a pure culture of a fungus allied to

* Engler's Bot. Jahrb., liv. (1916) pp. 246–61.
† Mycological Notes, No. 44, Cincinnati (1916) pp. 605–20 (figs.).
‡ Atti Reale Accad. Lincei, cccxiii. (1916) pp. 459–61.

Cladosporium Hormodendron, etc., which he describes as a new genus, *Harziella*.

The question is discussed as to whether the chestnuts are attacked during storage, and the manner of attack, whether during flowering or after the fruit is formed.

Diseases of Plants.* — A. Sharples reports extensive damage to *Hevea brasiliensis* from *Ustulina zonata*. He noted that boring insects almost always accompanied the attack of the fungus. The latter weakened the wood and made it more liable to insect boring. The fungus in turn follows in the further tracks of the insects. The double attack often kills the trees. Plantations ten to twelve years old suffer very considerably.

Juan J. Chavanne † enumerates several diseases of sugar-cane. *Cercospora Kopkei* forms oblong red spots on the leaves in spring and autumn, especially during the rainy season; *Leptosphæria Sacchari* causes oval blotches on the leaves of a white or yellow colour. The damage done by this fungus is inconsiderable, but infected parts should be gathered and burnt. A further series of leaf parasites are mentioned, but the damage they do is not serious.

G. Dorogin ‡ reports from near Petrograd an attack of adult celery-lants by two species of *Septoria*, *S. Apii* var. *Magnusiana* and *S. Apii-graveolentis* sp. n. The former caused blotches of varying appearance, dotted with few or many pycnidia, or the pycnidia were gathered in small groups over the leaf surface. The latter invariably formed spots strewn with pycnidia. The disease in both instances begins with the lowest leaves. The seeds may be infected and pass on the disease to the young plants.

Fungi and Lichens from Guam Island.§—Guam is one of the largest islands in the Marianne group, which lie about 2440 kilometres east from the Philippines. The islands are of volcanic origin. The list of plants has been compiled from all the known lists in the hope that it may prove a basis for future work. Louis Freycinet in 1819 made the first records of some twenty-five specimens which were determined and classified by Persoon; only thirteen of these are now recognizable. The last material collected was by Mary S. Clemens in 1911 and R. C. McGregor during the same year. A fairly long list is given with localities and bibliography.

* Agric. Bull. Fed. Malay States, iv. No. 4 (1916) pp. 98–105. See also Bull. Agric. Intell. Rome, vii. (1916) pp. 1038–9.

† Ministry Agric. Nac., Buenos Aires, 1916, pp. 5–32 (2 pl.). See also Bull. Agric. Intell. Rome, vii. (1916) pp. 1039–40.

‡ Ministry Agric. Mycol. Pl. Path., i. (1915) pp. 57–75. See also Bull. Agric. Intell. Rome, vii. (1916) p. 1041–2.

§ Mycologia, ix. (1917) pp. 4–22.

Lichens.

(By A. Lorrain Smith, F.L.S.)

Anglesea Lichens.*—W. G. Travis records the discovery of two crustaceous lichens at Newborough in Anglesea. They were found by Wheldon and Travis on the Lancashire sand-dunes, and described as *Arthopyrenia areniseda* and *Bacidia latebricola.* Travis examined the same type of locality at Newborough and was rewarded by finding the two lichens.

Schizophyta.

Schizomycetes.

Bacillus Sporogenes in War Wounds.†—M. Weinberg and P. Séguin describe an organism (*Bacillus sporogenes*) which they have isolated on thirty-four occasions from one hundred and twenty-six cases of gas gangrene infection. Choukévitch also has found this organism three times in eight cases of gas gangrene, and in seven out of nine cases of putrid wounds without gas. *B. sporogenes* resembles *B. œdematis maligni* (Vibrion septique) in many respects, but may be readily distinguished by means of serological tests. A V. septique agglutinating serum of a titre of $\frac{1}{1000}$ will not agglutinate strains of *B. sporogenes* even at so high a titre as $\frac{1}{10}$, although a good agglutinating rabbit serum with a titre of $\frac{1}{500}$ may be obtained for *B. sporogenes* after a month's immunization with the homologous organism. The addition of antitoxic anti-vibrion septique serum to a pathogenic dose of *B. sporogenes* has no inhibitory effect on the development of the characteristic lesions in the guinea-pig, and supports the conclusion that the two species are distinct. Filtrates of cultures of *B. sporogenes* were found, *in vitro*, to destroy the toxic effect of *B. œdematiens*, which probably explains why Conradi, Bieling and other German workers have pronounced the latter organism to be non-toxic. They were doubtless dealing with mixed infections.

Bacterial Etiology of Poison-Oak Dermatitis.‡—L. C. Frost reports seven cases of dermatitis due to *Rhus diversiloba*, or "poison oak," in which certain bacteria found on the leaves of the plant led him to believe that the dermatitis was caused by a definite organism and not by the irritation of the chemical poison secreted by the leaves. The following points in the etiology of the condition tend to bear out this contention—(1) there is an incubation period averaging four and a-half days; (2) complete immunity is shown by some individuals, which (3) may be lowered by a lowering of physical condition, change of climate, etc.; (4) exposure may be strictly limited to proximity to the

* Journ. Bot., lv. (1917) pp. 54–5.
† C.R. Soc. Biol. Paris., lxxix. (1916) pp. 1028–31.
‡ Med. Record., lxxx. (1916) pp. 1121–3.

plant, without actual contact; and (5) the appearance of the rash is often on an area untouched by the plant.

Bacterial cultures made from the leaves of the trees showed several types of cocci and bacilli; one short thick bacillus, about 3 to 4μ by 2μ, was apparently constant on all leaves examined, especially on the under surfaces. Growth was abundant on potato, but not on agar, gelatin or in broth. Inoculation of pure cultures in the skin produced slight redness after forty-eight hours, but without additional symptoms.

Further research along these lines is indicated.

Morphia Injector's Septicæmia (Whitmore's Disease).*—A. C. Stevenson writes as follows on the bacteriology of Whitmore's disease —"Amongst, and in the leucocytes in the alveoli, small beaded bacilli are seen. They do not retain Gram's stain, nor are they acid-fast. Their length and the number of beads in them vary considerably. When cultivated on ordinary media they appear as short rods, with generally two dark staining dots in them; on salt agar they grow into long filaments. They are motile in the early stages of culture, but this soon disappears.

"Inoculation into guinea-pigs invariably leads to a fatal result with the formation of nodules. If only a small dose is used, ½ to 1 minim of an eighteen hours' broth culture, intraperitoneally, enlargement and inflammation of the testicle is got, as in Strauss' sign in glanders, in about thirty-six hours. With large doses death ensues too quickly. Guinea-pigs are also capable of infection by feeding with cultures."

Bubonic Plague in England.†—A. R. Short reports two certain cases and one probable case of bubonic plague arising in England, which were treated last August at the Bristol Royal Infirmary. Two of the cases were confirmed in diagnosis by the usual bacteriological methods. Two of the patients and the father of the third worked in a rag factory, full of rats and fleas. Plague bacilli were demonstrated in a rat found dead in the factory. In discussing the portal of entry of the infection, the possibility of deliberate infection by the agent of a hostile country is suggested.

Pseudo-Tubercle in Guinea-pigs.‡—R. Van Sacegham, during the course of an epizootic of pseudo-tubercle among guinea-pigs, succeeded in immunizing the animals against virulent cultures of *Bacillus pseudo-tuberculosis rodentium*. He cites certain similar results obtained in 1912 by the late Major Sydney Rowland, R.A.M.C., in which the immunity to pseudo-tubercle was associated with immunity to *B. pestis* infection. From this the author wonders if vaccination with pseudo-tubercle would protect human beings against plague infection. [In his later work, however, Rowland showed that the immunity only applied to "laboratory," and not to "body" strains of *B. pestis*.]

* Trans. Soc. Trop. Med. and Hyg., ix. (1916) pp. 218–9.
† Brit. Med. Journ, ii. (1916) p. 327.
‡ C.R. Soc. Biol. Paris, lxxx. (1916) pp. 908–9.

Bacteriology of War Wounds.*—H. Tissier has, since the beginning of the European war, investigated the flora of a large number of lesions contracted during hostilities, and finds that among the aerobic bacteria the species most commonly met with is the *Enterococcus*. This organism, which is a normal inhabitant of the human alimentary canal, does not appear to be in itself pathogenic. It is very polymorphic, and appears in the form of cocci, diplococci, streptococci, and as coccobacilli, with or without false capsule. Next in order of frequency comes the *Staphylococcus albus*, then a variety of *Bacillus mesentericus*—(*M. fuscus*), which resembles Legros' *B. septicus ærobius*. More rarely one finds true streptococci (long-chained organisms which do not produce turbidity in liquid media, do not grow on potato, and produce toxin and active hæmolysin), *Diplococcus griseus non-liquefaciens*, *B. pyocyaneus*, *B. fluorescens viridus*, *Micrococcus candidus*, and *Sarcina lutea*. The dominant organisms in recent wounds, however, are the anaerobes—*B. perfringens*, *B. bifermentans*, *B. putrificus*, the Vibrion septique (*B. œdematis maligni*), and its variety, *B. sporogenes*, and the *Coccobacillus præacutus*.

New Bacterial Parasites of the Cockchafer.†—A. Paillot, while admitting that *Bacillus melolonthæ non-liquefaciens* is the principal cause of cockchafer septicæmia, states that he has isolated three other organisms from the blood of individual insects, which should be treated also as pathogenic. Two of these organisms, a diplococcus and a diplobacillus, which he calls respectively *Diplococcus melolonthæ* and *Diplobacillus melolonthæ*, have many biological and biochemical characters in common. They are both Gram-positive; they give very small colonies on ordinary agar, while on maltose and glucose agar the colonies are larger, and resemble those of the pneumococcus; they do not liquefy gelatin or coagulate milk. In bile-broth the diplococcus grows very abundantly; in pure bile the diplococcus grows feebly in long chains, while the diplobacillus does not produce any growth. Lactose broth is decolorised in twenty-four hours at 18° C. Both organisms produce acid in glucose, saccharose, and maltose media. The diplobacillus also ferments inulin, not so the diplococcus. The elements of the diplococcus measure 1–1·2 μ by 0·8–0·9 μ, those of the diplobacillus 1·6–1·8 μ by 0·4 μ. The third organism isolated, which he describes under the name of *Bacillus hoplosternus*, morphologically resembles *B. subtilis*, but may be readily distinguished from the latter organism in that it does not produce a scum on the surface of broth media. On ordinary agar it grows rapidly and abundantly, the colonies being large, spreading, and with wavy margins. Gelatin is slowly liquefied; ovoid spores are formed towards the third day. The bacillus is very pathogenic for cockchafers and the caterpillars of *Vanessa urticæ*. The grubs of *Lymantria dispar* are relatively refractory.

Toxic Effect of Sodium Chloride on Meningococcus.‡—C. Shearer shows that sodium chloride in 0·85 p.c. solution has a toxic effect on

* Ann. Inst. Pasteur, xxx. (1916) pp. 680–90.
† Comptes Rendus, clxiii. (1916) pp. 772–4.
‡ Proc. Roy. Soc., Series B, lxxxix. (1917) pp. 440–3 (3 figs.).

meningococcus, while if the dosage be increased, say to 1·5 p.c., NaCl is relatively harmless. If, however, $CaCl_2$ be added, the action of NaCl is antagonized, and if KCl also be added there is a copious growth of meningococcus. Distilled water failed to kill the coccus after twenty-four hours. From the foregoing results it might be inferred that 0·85 p.c. NaCl might be a substitute for Flexner's serum.

Protozoa in Relation to Soil Bacteria.*—T. Goodey records a continuation and an extension of previous work on this subject.† The recent conclusions are—1. Protozoa, especially amœbæ of the *limax* group and other large forms, can lead an active existence and multiply in soil and exert a depressing effect on bacterial numbers. 2. It is probable that for a given soil a certain point must be reached in protozoal numbers before the depression in bacterial numbers is caused. In the soil investigated this number appears to be approximately 30,000 *Amœba limax* per gramme. 3. It appears to be necessary to add the protozoa to a treated soil in a small quantity of untreated soil to ensure their having a suitable medium in which to grow and multiply. Under these conditions it is shown that they can increase in numbers and depress the numbers of bacteria. 4. It does not appear to be possible to carry out mass inoculations of protozoa into treated soil in such a way that they come into action and limit bacterial activity, and the explanation advanced to account for this failure is that the treated soil alone affords an unsuitable medium for the active trophic existence of protozoa.

Bacterium campestre.‡—Ethel M. Doidge contributes a paper on the occurrence in South Africa of *Bacterium campestre*, the organism which causes the black rot disease of the cabbage and other cruciferous crops. This organism had formerly been recorded only from Europe, America, and New Zealand, but the author's investigations showed that the disease caused by it was quite common in the neighbourhood of Pretoria. The most interesting point about the communication is that it seems clear that the organism was introduced into South Africa on cabbage-seed which came from England. From cabbage-seed imported by the nurseryman to whose premises the diseased plants first observed by Miss Doidge were traced, the organism was isolated, and its virulence proved by the successful artificial inoculation of two healthy cabbage-plants. It was suggested nearly twenty years ago by Stewart in America that this disease was probably disseminated by seedsmen, but actual proof was then wanting. Soon after this the organism was isolated by Harding from the surface of cabbage-seed produced by diseased plants in Long Island ; and now Miss Doidge has shown that by such means the disease may be carried from one continent to another. Soaking suspected seed for fifteen minutes in 1–240 formalin or in 1–1000 mercuric chloride is recommended as a suitable method of treatment.

* Proc. Roy. Soc., Series B., lxxxix. (1916) pp. 297–314.
† See this Journal, 1915, p. 397.
‡ South African Journ. Sci., xii. (1916) No. 10. See also Nature, Feb. 22, 1917, p. 500.

MICROSCOPY.

A. Instruments, Accessories, etc.*

(1) Stands.

"Le Microscope," by Van Heurck (First Edition).†—A copy of this scarce work has lately been presented to the Society, and its modest dimensions are in strange contrast with the bulk of its latest representative. It is dated 1865, and consists of 108 pages, with thirty-four figures in the text. Its purpose was to describe the Microscope as an instrument (71 pp.), and then to discuss its application to vegetal anatomy (33 pp.), a subject on which there was at that time no work in French. Amongst the instruments is an ingenious tri-ocular, by Nachet, intended for the simultaneous observation of an object by three observers. The tubes are separated by angles of 120°, and the image formed by the single objective is reflected by prisms through the tubes to the eye-pieces. The instrument was set on a small circular table, around which the observers sat at equal distances.

(2) Eye-pieces and Objectives.

Metrical Measures.‡—This title is scarcely appropriate to E. M. Nelson's article, which is chiefly occupied with the structure of pre-achromatic lenses and with their behaviour under certain conditions. Many of the early lenses examined by the author possessed certain excellencies, and their study revealed several interesting and useful points. The author's general conclusion is that stops are hardly wanted with low powers. With medium powers stops to 0·5 N.A. will be found advantageous, and a ½-in. with a 0·65 N.A. stop and a B or C eye-piece is a useful combination for pond life on a dark ground. "Penetration" really means the improvement in an image owing to the presence of a stop at the back lens of an indifferent objective.

(3) Illuminating and other Apparatus.

Berget's Differential Refractometer for Measuring Sea-water Salinity.§—Oceanographers require that the salinity of sea-water should be known to a degree of precision marked by the fourth decimal place and the half of the fifth. A. Berget has succeeded, by means of a

* This subdivision contains (1) Stands: (2) Eye-pieces and Objectives; (3) Illuminating and other Apparatus; (4) Photomicrography; (5) Microscopical Optics and Manipulation; (6) Miscellaneous.

† Published by Adrien Delahaye, 23 Rue de l'Ecole de Medicine, Paris.

‡ English Mechanic, civ. No. 2694, Nov. 10, 1916.

§ Comptes Rendus, clxiv. (1917) pp. 400–2.

microscopic method suitable for use on board ship, in attaining this degree of accuracy. He passes a beam of monochromatic light through the slit of a collimator on a rectangular trough with parallel faces, separated into two parts by a diagonal glass partition. The beam impinges at right angles on one of the faces of the trough, which thus forms a system of two opposite, equi-angled prisms. If these prisms contain liquids of the same index the ray traverses their system without undergoing deviation. But deviation ensues if the liquid in one differs from that in the other. If A be the common angle of the two prisms the deviation caused by the first liquid (index n) is $d = (n - 1)$ A; that, in the opposite sense, by the second liquid (index n') is $d' = (n' - 1)$ A. The resultant deviation is their difference, or $\Delta = (n - n')$ A. For measuring this deviation the luminous beam, on emerging from the trough, is received on an achromatic lens, which gives a real image of the collimator slit. This image is then examined by a Microscope provided with an ocular fitted with a micrometric screw. One of the liquids is a standard one of known density and consequent salinity, the other is the sample.

Benzoline for Microscope Lamps.*—S. C. A. has tried benzoline in place of paraffin with satisfactory results. The metal fount should be stuffed with cotton-wool—not too tightly—then fill with benzoline and allow to stand until the wool is thoroughly saturated. Any superfluous benzoline should be poured off. See that the wick is in contact with the cotton-wool, and that it does not become twisted when screwing on the burner. A lamp charged in this manner can be carried in any position; there is no smell, and the light is white. The lamp should not be filled in proximity to a naked light.

(4) Photomicrography.

Photography of Eye Specimens.†—R. H. Elliot gives the following points and says that if a good photograph of a sectioned eye is to be obtained attention to certain points is essential:—1. The eye must lie completely under water. 2. The source of light must be good and even. 3. The camera must be placed vertically above the object in order to avoid reflexes. 4. The object photographed must be so placed that its image will occupy the centre of the plate, and adjustment should be available to secure this end with a minimum of inconvenience. 5. A simple arrangement is necessary to fix the eye section in position during the whole period of exposure. 6. To save unnecessary retouching the object should be photographed upon a dark and even surface, so that the background should in no way disturb the attention of anyone looking at the picture. 7. A suitable camera should be selected. 8. The question of exposure must be very carefully studied. The author, after discussing these points in detail, appends an addendum on magic-lantern slide-making.

* English Mechanic, March 2, 1917, p. 105.
‡ Proc. Roy. Soc. Med., x. (1917) pp. 7–13 (Opthal. sect.).

(5) Microscopical Optics and Manipulation.

Nitzschia singalensis as a Test-Object for the Highest Powers.*—A. A. C. Eliot Merlin, as the result of examination of a specimen of *Nitzschia singalensis* mounted in styrax, thinks that *Amphipleura pellucida* can no longer be regarded as the supreme test for objectives of the highest power. He is of opinion that, as a test for first-rate objectives of the largest aperture, *N. singalensis* must henceforth rank far above *A. pellucida*, and that any failure to resolve its transverse striæ with lenses of 1·30 N.A. and upwards will indicate a faulty objective or faulty manipulation. Nevertheless, the test is severe, and when accomplished with axial light requires good eyesight in addition to good optical means. In practice the author has found that the transverse striæ of *N. singalensis* can be revealed with a good semi-apochromatic objective of 1·33 N.A. by means of axial light and a Gifford screen. His observations gave 115,200 and 116,000 to the inch.

M. A. Ainslie does not altogether support this view, and is inclined to think that, until specimens are obtainable of *N. singalensis* mounted in realgar, the resolution of the transverse striæ of *A. pellucida* in that medium will remain the best existing test of the all-round capacities of an oil-immersion objective.

(6) Miscellaneous.

Quantitative Microscopy.†—Under this title T. E. Wallis describes experiments whose aim has been to devise a general method of procedure which will give precision to counts made under the Microscope, and so enable one to obtain, by the use of this instrument, quantitative results which will carry conviction in much the same way as do figures based upon ordinary chemical processes. The substances dealt with were certain food materials such as are frequently adulterated. The general statement of his method is as follows :—1. Make a mixture of the pure substance with an equal weight of the adulterant whose amount it is desired to determine. The two substances may either be dried at 100° C. or, preferably, used air-dry ; estimate the moisture present and apply the necessary corrections in the calculations. Mix 0·2 grm., or other convenient weighed quantity of this standard mixture, with 0·1 grm. or other suitable amount of *Lycopodium* and sufficient of the suspending fluid (e.g. mucilage of tragacanth) to produce a liquid of which one drop, when mounted and examined with a $\frac{1}{6}$-in. objective, shall show from ten to twenty *Lycopodium* spores in each field. In most cases this result will be obtained when the total volume is about 20 c.cm. A drop of the suspension is transferred to a slide by means of a glass rod, and a cover-glass is applied. Count the number of particles of adulterant and of *Lycopodium* spores in ten fields. Mount a second drop on another slide, and again record the counts. Find, for each set of ten counts,

* Journ. Quekett Micr. Club. xiii. (1916) pp. 111–6 (1 photo.).
† The Analyst (Journal of Public Analysts and other Analytical Chemists), Dec. 1916; also as a separate pamphlet, 19 pp. (1 fig.).

the ratio of the number of *Lycopodium* spores to the number of characteristic elements of the adulterant, and express the results as the number of characteristic elements counted for every 100 *Lycopodium* spores. The numbers found for the two sets of counts should not differ by an amount greater than 10 p.c.; should they do so fresh counts must be made. 2. Mix 0·2 grm., or other suitable amount of the sample in which the percentage of adulterant is to be determined, with 0·1 grm., or other convenient amount, of *Lycopodium* and about 20 c.cm. of suspending fluid. Mount a drop on each of two slides, and count ten fields on each. Calculate the ratio of the number of spores of *Lycopodium* to the number of characteristic elements of the adulterant, and express the result in the same form as for the standard mixture. 3. The numbers obtained for the foreign substance in the two sections of work are directly proportional to the amounts present, and a simple calculation gives the quantity sought.

It will be noted that the novelty of the author's method consists in using the *Lycopodium* spores as a kind of unitary standard, and thorough admixture is a necessary preliminary to success. There does not seem, however, to be any difficulty in this, and in some cases no further preparation was necessary. But the author found that as a general principle, absolutely necessary sometimes, the spores should be suspended in a suitable liquid, or semi-liquid, and that the choice of this liquid depended on the subject under investigation. He gives full details, and his results attained a very high degree of accuracy. The mixtures relating to his experiments were: wheat-flour and corn-flour; potato-starch and maize-starch; dried mustard and dried corn-flour; wheat-flour and potato-starch; white pepper and ginger; white pepper and rice-starch; gentian-root and cocoanut-shell.

B. Technique.*

(1) Collecting Objects, including Culture Processes.

Note on the Isolation of Enteric Organisms.†—F. Denert and G. Mathieu are of opinion that the variable results obtained by different workers on the isolation of enteric organisms by means of malachite-green media is due to variations in the quality of the commercial product. Working with malachite-green (Grübler) they found that *Bacillus typhosus* multiplied rapidly in solutions of $\frac{1}{2000}$ to $\frac{1}{5000}$ (with the exception of laboratory strains), that *B. paratyphosus A* developed better than *B. typhosus*, and that *B. paratyphosus B* produced the best growth of all. They recommend the following methods of isolation:—*Stools*: dilute a portion of the stool with salt solution, and inoculate two tubes containing pepton water added to $\frac{1}{8000}$ and $\frac{1}{4000}$ malachite-green re-

* This subdivision contains (1) Collecting Objects, including Culture Processes; (2) Preparing Objects; (3) Cutting, including Embedding and Microtomes; (4) Staining and Injecting; (5) Mounting, including slides, preservative fluids, etc.; (6) Miscellaneous.

† Comptes Rendus, clxiv. (1917) pp. 124–5.

spectively. Incubate at 36° C. Take samples every four hours, and inoculate Endo's medium and litmus-lactose agar plates. *Water*: 50 c.cm. of the water to be analyzed is added to tubes containing 50 c.cm. pepton water containing $\frac{1}{8000}$ and $\frac{1}{4000}$ malachite-green respectively; then proceed as above.

(2) Preparing Objects.

Embryonic Development of Trichogramma evanescens: Monembryonic Egg-parasite of Donacia simplex.*—J. B. Gatenby used the following technique. As the egg of *Donacia* is covered by a thick chorion sectioning is a difficult business. The parasitized egg-masses were preserved in Petrunchekewitsch with a little more nitric-acid than usual. A mixture of Petrunchekewitsch and Bouin gave about equal results. In some cases the eggs were pricked and the whole thrown into picro-nitric. After some trials Petrunchekewitsch was almost exclusively used. In using this fixative it is not necessary to prick the eggs. Ordinary preservatives will not penetrate the chorion. The eggs were left overnight in the Petrunchekewitsch and washed out in 70 p.c. alcohol. When in xylol the eggs were pricked with a fine needle and placed in the paraffin bath. The eggs were cut into their groups, 5 μ in thickness on a Jung microtome, each section being painted with celloidin and ether. By staining overnight in iron-hæmatoxylin a suitable differentiation could be got while Ehrlich and the carmines were useless. In some cases alternate slides were counter-stained in orange G or dilute acid fuchsin.

Treatment of Tuberculous Sputum by Pyridine.†—M. Giraud and E. Derrien give the following method for rendering sputum homogeneous. It is mainly intended for the examination of tuberculous sputum. To 10 c.cm. of sputum are added 15 c.cm. of cold pyridine. The mixture is then shaken well in some vessel and afterwards allowed to stand for five minutes to hours. When liquefied the mixture is centrifuged. The deposit is used for making films in the usual way, but if there should be a surface pellicle this also should be examined. The films when dry are stained by the Ziehl-Neelsen method. The authors find that this procedure gives very satisfactory results.

Spreading Blood-films.‡—L. Tribondeau recommends the use of a scissors' blade or a straight-edged knife for spreading blood on slides. This procedure does not appear to possess advantages over those obtained by older methods, e.g. short edge of a slide, cigarette-paper, strip of thin rubber, glass roller, etc. It is chiefly a question of the manipulator. The writer of this notice, who has had many assistants in his time, has remarked that only a few of these had the deft use of their fingers—these made good blood-films; about the rest is silence.

* Quart. Journ. Micr. Sci., lxii. (1917) pp. 149–87 (3 pls.).
† C.R. Soc. Biol. Paris, lxxix. (1916) pp. 376–7.
‡ C.R. Soc. Biol. Paris, lxxix. (1916) pp. 1011–2.

(3) Cutting, including Embedding and Microtomes.

Collar Cavities of Larval Amphioxus.*—K. M. Smith and H. G. Newth examined four larval stages. Larvæ which had been fixed in Hermann's fluid were obtained from the Naples Zoological station. They were cut into series of transverse sections by the method of double embedding in celloidin and wax, and the sections 4 μ or 5 μ thick were stained variously with Delafield's hæmatoxylin, thionin, alcoholic hæmatein, or with an aqueous solution of picro-nigrosin for the special purpose of making plain the relations of the myosepta.

(4) Staining and Injecting.

Staining of Spirochæta Ictero-hæmorrhagica.† — L. Martin, A. Petit and A. Vandremer have adopted the following technique for the preparation and staining of *Spirochæta Ictero-hæmorrhagica* :—1. A part of the liver of an infected guinea-pig, autopsied six hours after death, is roughly ground and mixed with 10 c.cm. salt solution. 2. It is then filtered, the filtrate showing with the ultra-microscope the presence of numerous active spirochætes. 3. The filtrate is centrifuged for ten minutes, a precipitate divided into two portions being obtained, a deep red layer and a superficial white layer. The supernatant fluid is yellowish and cloudy. 4. The supernant fluid is pipetted off and replaced with salt solution, the processes being repeated until the overlying fluid is clear and colourless. A small portion of the superficial layer of the precipitate (in which the spirochætes are collected) is then taken up with a pipette. Thin slide preparations are prepared, dried and stained by Lœffler or van Ermengen method.

A. Lœffler's method :—Fix with alcohol and ether, cover with fuchsin solution and warm gently, wash with distilled water, rinse three times with absolute alcohol, cover with alkaline gentian-violet and warm gently. Wash with distilled water and dry.

B. van Ermengen's method :—Follow the classical method of staining for flagella, but instead of employing carbol-fuchsin, use diluted alkaline gentian-violet.

Demonstrating Nuclei of Nerve-fibres.‡—H. E. Reburn recommends the following method for general routine work when a rapid result is wanted. The fresh nerve is teased on a slide in the usual way, the preparation being kept moist with the breath. A drop of absolute alcohol is added, and then a drop of Ehrlich's hæmatoxylin, followed by a drop of methylen-blue. Either dye may be used alone, but the nuclei are most deeply stained when both are employed. An alcoholic solution of eosin may be substituted for the absolute alcohol ; the

* Quart. Journ. Micr. Sci., lxii. (1917) pp. 243–51 (1 pl.).
† C.R. Soc. Biol. Paris, lxxix. (1916) pp. 1053–5.
‡ Quart. Journ. Micr. Sci., lxii. (1917) pp. 217–9.

alcohol here is the essential reagent, but the eosin provides a red counter-stain. The preparation is then washed, cleared and mounted in the usual way.

Fixing and Staining Toxoplasma.*—H. G. Plimmer found these parasites in the blood of the general and in that of the pulmonary circulation, and also in the liver, of animals kept in the Zoological Gardens. Most of the films were fixed wet in the vapour of iodine dissolved in chloroform, and were stained with Giemsa's stain, made alkaline, and followed by acetene and xylol. Others were fixed by the Carnoy-Lebrun method and stained with Weigert's hæmatoxylin, or with alkaline Giemsa stain.

6. Miscellaneous.

Demonstrating Silicious Particles in Lung.†—The nature of the particles of mineral matter which become embedded in the lung-tissue in cases of miner's phthisis has been determined by W. Watkins-Pitchford and J. Moir, by microscopical examination in polarized light of specially prepared sections of silicotic lungs, their results being given in Publication No. VII. of the South African Institute for Medical Research (Johannesburg, 1916). In polarized light the field is suggestive of a starlit sky, but in ordinary circumstances only the larger particles are so visible. The particles have the form of irregular and angular, more or less elongated, chips or flakes, the majority being less than 2 μ in diam., and very rarely reaching as much as 14 μ. The smaller flakes, when lying flat, have not sufficient thickness to react on polarized light, and they are only seen as streaks when they are set edgeways (the light then traversing a longer path through the doubly refracting medium). Further, the particles are obscured by the tissue in which they are embedded. The method previously adopted of destroying the lung-tissue by means of hydrochloric acid and potassium chlorate also resulted in the destruction of some of the mineral matter. This objection is overcome by treating the sections with nitric acid or strong hydrobromic acid. Such prepared sections were compared with preparations of the dust collected from the air in the Rand gold mines, and of the powder obtained by finely grinding the rock ("banket") from these mines. The mineral species identified include quartz (constituting more than 99 p.c. of the particles), sericite-mica, rutile, zircon, and tourmaline, and perhaps chlorite. Similar particles of mineral dust were also detected in the tissue of normal lungs; for example, the two lungs of a farmer, who had never worked in the mines, were estimated to contain a hundred thousand million particles of foreign mineral matter, whereas in the lungs of a miner affected with the disease the estimate reaches the appalling number of twenty to thirty millions of millions of such particles.

* Proc. Roy. Soc., Series B, lxxxix. (1916) pp. 291-6 (10 figs.).
† Nature, Jan. 25, 1917, p. 416.

Metallography, etc.

Heat-treatment of Steel Locomotive Axles by Water- and Oil-quenching.*—The results obtained by water-quenching and by oil-quenching of two axle forgings, both from the same steel-melt containing 0·6 p.c. carbon, have been compared by C. D. Young. The mechanical properties of the two axles after treatment were generally similar, except that water-quenching gave a higher elastic limit. The structure of each axle (illustrated by photomicrographs) showed characteristic differences. The water-quenched axle had an irregular sorbitic structure, with very little ferrite network, while the oil-quenched axle showed a more regular structure, with a moderately thick network of ferrite. The assembling of the ferrite, liberated in passing through the critical range, is restricted to a less extent during the less rapid cooling of oil-quenching.

Splitting of Brass Condenser Tubes.†—The results of an investigation into the causes of spontaneous cracks or splits in brass condenser tubes are set forth by A. E. White. The phenomenon is ascribed to the existence of a state of molecular strain in the metal due to insufficient annealing between the drawings during manufacture, or to incomplete annealing after the final drawing. The most suitable composition of brass and the proper treatment, thermally and mechanically, during manufacture into tubes, to obtain a final product which will be in a state of equilibrium free from mechanical strains, are considered in detail. The guidance given by a study of microstructure in determining the requisite heat-treatment is illustrated by a complete series of photomicrographs showing changes in structure of a drawn tube after annealing at varying temperatures, followed by different rates of cooling. No change is effected by annealing below 400° C. Above 400° C. the distorted crystallization is broken up and replaced by a fine equi-axed crystallization showing no distortion. With increase of temperature up to 800° C. this crystallization becomes progressively coarser. Above 800° C. the structures show characteristic "burnt" crystals. A special etching reagent, consisting of hydrogen peroxide and ammonia, was employed.

It is recommended that a microscopical examination should be included in the specifications to be fulfilled by condenser tubes before being accepted for service. Microsections of the tubes at a magnification of 75 diam. should show no strains and no grain larger than ¼ in. diam.

Recrystallization of Deformed Low-carbon Steel as a Factor in the Failure of Boiler Tubes.‡—It is well known that recrystallization

* Proc. Amer. Soc. for Testing Materials, xvi. pt. 2 (1916) pp. 53–64 (5 figs.).
† Proc. Amer. Soc. for Testing Materials, xvi. pt. 2 (1916) pp. 152–67 (7 figs.).
‡ Proc. Amer. Soc. for Testing Materials, xvi. pt. 2 (1916) pp. 80–110 (24 figs.).

and growth of the ferrite crystals occur on annealing, at temperatures below the critical range, a low-carbon steel which has been previously strained in any way. A. E. White and H. F. Wood describe experiments with a steel containing 0·11 p.c. carbon, which had been previously locally deformed by making a Brinell indentation with a ball of 5 mm. diam. under a pressure of 800 kilogrm., with the object of determining the relation between time and temperature governing crystal growth on annealing at temperatures below the critical range. Photomicrographs are given showing (1) the structures of the steel in the neighbourhood of the indentation, and that of the unstrained metal at a distance from the indentation; (2) the corresponding structures after annealing at various temperatures from 850° C. to 550° C. for varying lengths of time. The strained crystals only showed any change in structure. At temperatures down to 700° C. recrystallization took place in a fraction of a minute. At 675° C. a period of eight minutes was required. Below 675° C. the time required for crystal growth is considered to vary in geometrical progression for every fall in temperature of 25° C.: e.g. at 550° C. annealing for thirty-five hours was required before crystal growth was noticed. Annealing for longer periods than the critical period for each temperature produces very coarse structures.

The bearing of these results upon the causes of frequent failures among low-carbon steel boiler tubes is next considered. The possible overheating of a tube by the deposition of scale on the water side might result in rapid crystal growth and the weakness associated with a coarse crystallization. Photomicrographs are given of the structure of a failed tube, showing that in this instance crystal growth had clearly taken place, the structure being exceedingly coarse on the fire side. To prevent failures the deposition of scale and consequent overheating should be avoided, or steel of a higher carbon-content might be employed.

PROCEEDINGS OF THE SOCIETY.

AN ORDINARY MEETING

OF THE SOCIETY WAS HELD AT 20 HANOVER SQUARE, W., ON WEDNESDAY, FEBRUARY 21ST, 1917, MR. E. HERON-ALLEN, F.L.S., F.Z.S., ETC., PRESIDENT, IN THE CHAIR.

The Minutes of the preceding Meeting, having been circulated, were taken as read, approved, and signed by the President.

Mr. Cyril F. Hill, Hon. Treasurer, in presenting the Financial Statement and Report, duly audited by Messrs. Soar and Grundy, apologised to the Society for the fact that the accounts were not out in time for the January Meeting; but certain outstanding accounts did not come in till February. Fellows would note that heavy depreciation of the Society's investments was brought about by the removal of the "minimum prices." But it was not considered necessary to write them down to the rock-bottom figure, as there was every probability of their appreciating after the war.

The statement was unanimously accepted.

Mr. D. J. Scourfield, in drawing attention to the exhibit of British and foreign species of *Daphnia*, said that although confined to specimens of true *Daphnias*, it exemplified the considerable range of variation found in a single genus. Numerous species of *Daphnia* had been described in the past, but recently the tendency had been to put a number of these forms together again, under a few of the older specific names. Thus under *Daphnia pulex* several forms formerly regarded as distinct species were now classed as varieties. A specimen of *D. obtusa* (included in the exhibit) was a case in point. Of *D. longispina*, which seemed to include nearly all the forms seen in the lakes of this country, and in European lakes generally, he was able to show one or two examples, more especially one called *D. galeata*, which was very characteristic of the Scottish lochs. The specimen *D. cristata*, although not yet recorded in this country, might be expected to occur in the north of Scotland, and was peculiar in having only four instead of five setæ on the three-jointed branch of the swimming antennæ. Other forms shown were *D. magna*, the largest native species, and *D. atkinsoni*, probably a southern form, only occurring rarely in this country, and possibly derived from winter eggs introduced by migratory birds. *D. lumholtzi*, first described by Sars from specimens reared from dried mud sent from Australia, afterwards found in Palestine, and later by

Dr. Cunnington in Lake Nyasa, was represented by a specimen from the last-named locality. The spine on the head was enormous compared with that in other *Daphnias*, and the shell spine was also very long. Sars stated that this species swam in a nearly horizontal position, and that the movement was not jerky like most other *Daphnias*, but graceful and uniform. Another species shown, *D. carinata* var. *cephalata*, was found only in Australia, and was characterized by a truly monstrous development of the thin keel running over the top and back of the head.

The mounted specimens were prepared by Mr. Rousselet, who those present would be delighted to learn was slightly improved in health.

Dr. Cropper said that he had been elaborating, in conjunction with Mr. Row, of King's College, methods to concentrate dysenteric stools, i.e. to get rid of as much debris as possible by certain physical and chemical means, while leaving the associated amœbic cysts uninjured. In addition, he had devised a method of counting entamœba cysts in stools. There were two methods in use for concentrating stools and other material. The first depended entirely upon repeated centrifugalization, and subsequent filtration of the centrifuge deposit through a fine-meshed silk cloth. By this means a large quantity—roughly, 90 p.c. —of the debris was removed from the stool, and the concentrate so obtained would be suitable for experiments on the cultivation of entamœba, and had been used by Drs. Drew and Griffin.

The second method was employed chiefly to assist in the diagnosis of amœbic dysentery. Ether was added to an emulsion of the stool, in a separating funnel, and on separating-out carried up a large amount of the debris to the top. The subjacent liquid when drawn off contained the bulk of the cysts originally present in the stool, admixed with a minimum amount of debris.

Lastly, for the enumeration of cysts in stools. Dr. Annie Porter, using the hæmocytometer to count lamblia cysts, found large variations—from being entirely absent, to something like a thousand million or more passed per day. In the case of entamœba infections the number is much smaller, and in one typical case examined ranged from 10,000 to 60,000 cysts per gramme of stool, to an average of about five million cysts per day. The hæmocytometer was unsuitable for counting entamœba cysts, because in an average infection only one cyst might be present in each chamberful. A method had therefore been devised of ruling lines on a slide $\frac{1}{2}$ mm. apart, and counting with a low-power. By using an emulsion of the right strength, it became a simple matter to count 20 c.cm. at a time, and this has been employed as a routine method.

Drs. A. H. Drew and **Una Griffin** then communicated their paper on the "Parasitology of Pyorrhœa alveolaris," which appears *in extenso* in the Journal of the Society. After a short discussion, in which Drs. Taylor, Rudd Leeson and Eyre, and Mr. Heron-Allen took part, the President proposed from the Chair a hearty vote of thanks to the authors for their contribution, which was carried by acclamation.

The President then proposed a vote of thanks to Mr. Angus for so kindly lending the Microscopes for the evening's demonstrations. The vote of thanks was carried unanimously.

The President announced that the next Meeting of the Society would be held on March 21, at 8 o'clock, and the next Meeting of the Biological Section on March 7, at 7 o'clock, when Dr. J. Rudd Leeson would communicate "Observations on the Radulæ of the *Gasteropoda*" (to be illustrated with numerous slides).

New Fellows:—The following were elected *Ordinary* Fellows of the Society: Dr. A. A. Perira, Miss Nancy M. Robinson, Mr. Robert S. W. Sears.

The following Specimens, Apparatus, etc., were exhibited:—

By Dr. A. H. Drew and Dr. Una Griffin:—

Amœba buccalis sp. n., from case of pyorrhœa, showing all nuclear chromatin in one piece. (Iron-hæmatoxylin stain.)
A. buccalis, from an anaerobic culture at 37° C. (Hæmatoxylin stain.)
A. buccalis sp. n., from anaerobic culture. (Stained by Giemsa.)
Entamœba gingivalis, from case of acute pyorrhœa, showing the small central caryosome and the ring-shaped arrangement of chromatin. (Iron-hæmatoxylin stain.)
E. gingivalis, from case of pyorrhœa. (Stained by Giemsa.)
Spirochætes, from acute pyorrhœa. (Congo-red film.)

By Dr. J. W. Cropper:—

Bacteria isolated from impure amœba cultures. Amœba was subsequently grown in "pure-mixed" culture with each of the following:—

Bacillus prodigiosus.
B. flavo-coriaceus.
Amœba parasite.
B. fluorescens non-liquefaciens. (Gelatin slope.)
,, ,, (Gelatin stab.)
,, ,, (Plain gelatin slope.)
Amœba and *B. fluorescens non-liquefaciens.*
Plain agar stab.
,, ,, slope.
,, gelatin slope.

Method of counting *Entamœba coli* cysts in a 2·5 p.c. emulsion.
"Culture concentrate" of stools containing *E. coli* cysts.
Enumeration of *E. coli* cysts in an "ether concentrate of stools."
Culture concentrate of *E. histolytica* (scanty infection).
Debris removed from a "concentrate" by filtration through silk, demonstrating the few cysts relative to the debris.

Single *Limax* amœba cyst, isolated for the preparation of a culture.
Method used for ruling counting-slides.
Slides ruled in columns about $\frac{1}{2}$ mm. apart, used for counting Entamœba cysts in stools.
Method for counting Entamœba cysts in stools by means of a cover-glass ruled in squares.
Preparation of an ether concentrate of Entamœba cysts in stools.
Method of filtering fæcal emulsions through fine-meshed silk.

By Mr. D. J. Scourfield, F.Z.S. :—

Daphnia atkinsoni, from Norfolk.
D. carinata var. *cephalata*, from Queensland.
D. cristata, from Finland.
D. cucullata var. *Kahlbergensis*, from Cheshire meres.
D. galeatea, from Loch Vennachar.
D. lumholtzi, from Lake Nyasa.
D. magna, from Sussex.
D. pulex var. *obtusa*.

AN ORDINARY MEETING

OF THE SOCIETY WAS HELD AT 20 HANOVER SQUARE, W., ON WEDNESDAY, MARCH 21ST, 1917, AT 8 P.M., MR. E. HERON-ALLEN, F.L.S. F.Z.S., ETC., PRESIDENT, IN THE CHAIR.

The Minutes of the previous Meeting, having been circulated, were confirmed, and signed by the President.

The President read the nomination form for Mr. Frank W. Lacy ; he also directed that the ballot for the election of Mr. Henry James Howard and Colonel Alfred Ryland be taken. These gentlemen were subsequently declared duly elected.

The receipt of two Donations to the Society were then announced. The first was a stand for the Society's projection apparatus, which had been presented by Messrs. J. E. Barnard and C. F. Hill, Hon. Treasurer. The second presentation was four slides of Mycetozoa, by Mr. H. J. Howard. On the proposition of the President, a vote of thanks was returned to the gentlemen named for their gifts.

Mr. Scourfield then referred to an exhibition of specimens of *Chlamydomonas*, sp. incert., that he had prepared, with the assistance of Messrs. Grundy and Wilson. There were about thirty known species.

Chlamydomonas was a representative of the primitive type from which many other forms of Volvocaceæ had probably developed. It was equivalent to the minute green cells found on *Volvox*. An interesting fact about the specimens exhibited was that they had been in a little tube in the crowded condition as shown for quite a month, yet they seemed to be as active now as they were at first. Under one of the Microscopes would be found some specimens which had been preserved by the simple method of putting a little formalin into the water, and it was interesting to note that the flagella and nuclei were shown quite well.

The President thanked Mr. Scourfield for having brought the exhibit.

Mr. Kenneth Goadby, L.R.C.P. M.R.C.S. D.P.H. L.D.S., read a paper on "The Bacteriology of War Wounds," which was illustrated by a series of lantern slides prepared by Mr. C. F. Hill.

The President said he would not attempt to comment on the paper which Mr. Goadby had just communicated; it was one of absorbing interest, and one which could be said to be painfully personal in its interest to each member present—to some, perhaps, more than to others. He thought they ought to consider themselves very much privileged that Mr. Goadby had shown them these results of his studies.

Mr. Robotham, Dr. Leeson, and **Dr. Eyre** having spoken, a hearty vote of thanks was accorded to Messrs. Goadby and Hill.

The President proposed a vote of thanks to Mr. Angus for the loan of the Microscopes, and also to Messrs. Beck for the loan of the objectives, which had been used for the evening's exhibits. This was carried unanimously.

The President announced that the Aeronautical Institute of Great Britain invited Fellows of this Society to hear a paper, on March 29, at 8 p.m., on "The Necessity of New and Special Treatment of Metals employed in Aircraft Construction." Those Fellows who wished to accept the invitation could obtain tickets from the Assistant Secretary.

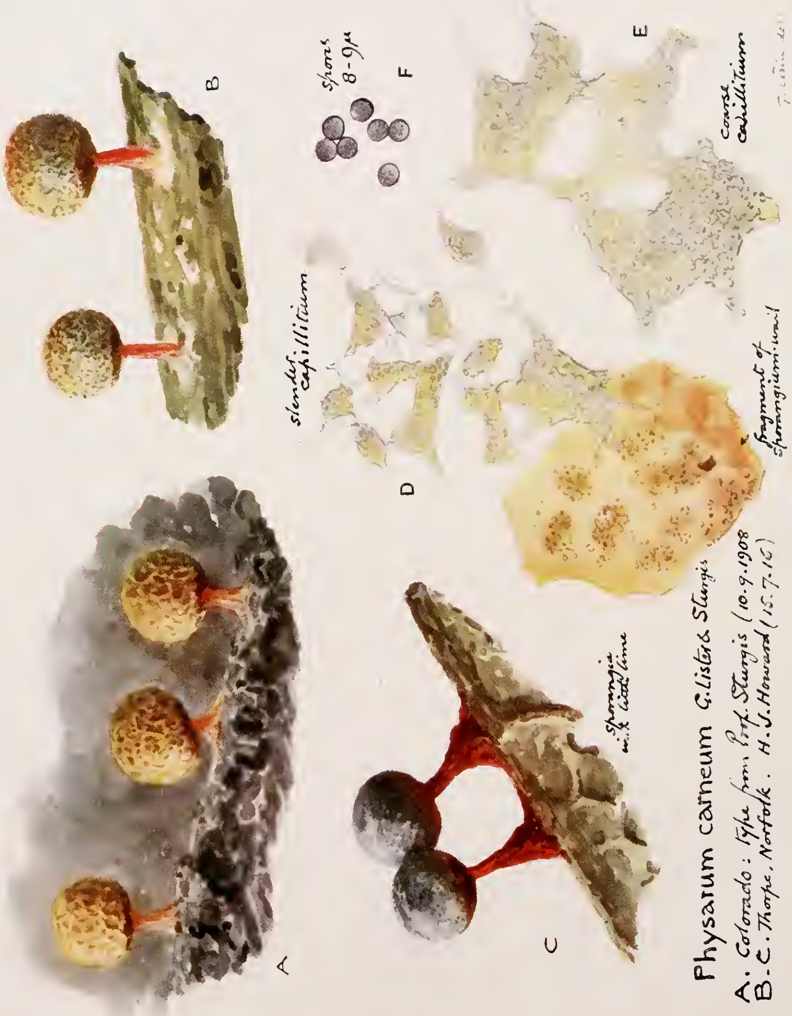
The following Specimens were shown:—

By Mr. Kenneth Goadby:—

Gas-gangrene organisms in muscle. *Bacillus perfringens.*
Infected muscle. Gas gangrene.
Destruction of elbow-joint cartilage.
Colony of *B. œdematis maligni*, living.
B. perfringens and *B. œdematis maligni*, in tissue.
Digested muscle-fibres. *B. œdematis maligni.*

By Messrs. D. J. Scourfield, J. Grundy, and J. Wilson:—

Chlamydomonas sp.? in great numbers, accompanied by various species of *Euglena, Phacus, Trachelomonas*, etc., and *Paramæcium aurelia.*



Physarum carneum G.Lister & Sturgis

A. Colorado: Type from Prof. Sturgis (10.9.1908)
B.C. Thorpe, Norfolk. H.J. Howard (15.7.16)

JOURNAL

OF THE

ROYAL MICROSCOPICAL SOCIETY.

JUNE, 1917.

TRANSACTIONS OF THE SOCIETY.

III.—*Notes upon Physarum carneum G. Lister and Sturgis: A New British Species of Mycetozoa.*

By Henry J. Howard, F.R.M.S.

(*Read April* 18, 1917.)

Plate XVIII.

On July 16, 1916, while searching for Mycetozoa in the grounds attached to Mousehold House, Norwich, a gathering was made of what appeared to me to be an unknown species.

The following note was made on the spot: "On old bramble stems a fairly large gathering of stout, stalked, reddish-brown sporangia, not quite mature, but which dried during the morning to pale orange-buff sporangia, with lime-granules in the sporangium-wall clearly visible under a pocket lens." Four days later, the same species was found on dead bramble and bracken stems; a visit on July 29 failed to yield further specimens.

I was unable to forward a specimen to Miss Lister for her

EXPLANATION OF PLATE XVIII.

Physarum carneum G. Lister and Sturgis.

A. Colorado. Type from Professor Sturgis (September 10, 1908).
B–C. Thorpe, Norfolk. H. J. Howard (July 15, 1916). B is a typical form, while C is an almost limeless form.
D. Showing fragment of sporangium-wall with slender capillitium showing smaller lime-knots and abundant connecting threads.
E. Coarser, almost *Badhamia*-like capillitium.
F. Spinulose purple-brown spores, 8–9 μ.
G. Fragment of sporangium-wall.

G. Lister, del.

kind consideration till early in September. Almost by return of post Miss Lister informed me that my find was *Physarum carneum* G. Lister and Sturgis, and that it was the first known British gathering.

Naturally, a further visit to the wood was made at the earliest opportunity; this was on September 16. *P. carneum* was found in the same spot and also in another place; the sporangia were in an immature state, and of a pale orange-yellow colour. Later, sporangia were found in all stages of development: opaque white, pale amber, sessile and stalked sporangia being found upon one stem of bracken. In every case, even in the immature specimens, there was a cup-like darker area where the stalk joined the sporangium-head. Specimens were found over quite a wide area as late as September 30.

Here a brief account of the wood and the exact habitat of the species may prove of interest, as the locality has yielded several specimens of Mycetozoa hitherto not recorded in the Norfolk lists. The area could scarcely be termed a wood in the true sense of the word, but it is somewhat varied in character, combining heath, low banks, and hills covered with bramble and bracken and surmounted with fir- and oak-trees. The portion yielding several species of Mycetozoa consists of gently sloping banks of rich dark earth, with a path between; the banks render the portions adjacent to the path shady and fairly damp, even in summer. It was in the dense growth of brambles that *P. carneum* was found.

Armed with thick leather gloves, and a stout stick, dressed preferably in one's oldest clothes, one had to beat a passage into the dense undergrowth of brambles and get down on hands and knees upon a mackintosh square to scan the broken stems. The colour of the sporangia made detection difficult except upon very close inspection.

Physarum carneum G. Lister and Sturgis was first found, in some abundance, on dead wood on Cheyenne Mountain, Colorado Springs, by Dr. W. G. Sturgis, in the autumn of 1908, and was described in the Journal of Botany.*

In the Norfolk gatherings, although the actual plasmodium was not found, sporangia of an opaque white colour were gathered which could not have been far removed from the plasmodium stage. These became translucent and of a pale amber colour; afterwards they became more opaque, showing a darker cup-like basal area. The colour then became a deeper orange-yellow, and the evenly-distributed lime-granules made their appearance in the sporangium-wall. The sporangia were mostly scattered in short rows on stems a few inches from the ground, but in some cases were gregarious; they were stalked and globose as a general rule,

* Journ. Bot., xlviii. (1910) p. 73.

and 0·4–0·6 mm. in diam. Sessile globose forms, and also plasmodiocarps, were found.

In the type-specimens the stalks are flesh-red in colour and almost translucent, but in the grey almost limeless sporangia the stalks are orange-brown and enclose refuse matter. The spores are purplish-brown, spinulose, 8 μ in diam., with a smoother patch on one side, marking, as in many other species, where dehiscence would occur in germination.

In some of the Norfolk specimens the capillitium shows small white or pale yellow lime-knots, with a network of hyaline connecting threads; in others the capillitium is stouter and almost *Badhamia*-like in character.

Previous to the recent gathering only one other European specimen was known; this was found by the Rev. C. Torrend in the grounds of Collegia de Campolide, Lisbon, in December, 1907. Dr. Torrend's specimens are pale buff, paler than are the type, but not paler than the lightest Norfolk ones; the sporangia-walls are not so strongly thickened below, and are less deep orange when mounted. The stalks also are pale pinkish-buff, with deposits of nearly white lime-granules in the walls. Some of the Norfolk specimens rise from a circular, white hypothallus. Miss Lister remarks: "Torrend's specimen was puzzling to us when we received it; only a few sporangia were sent; we tried to put it into *Craterium aureum*, but it was never happy there."

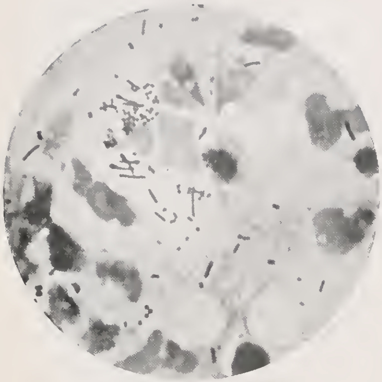
Another new find for Norfolk was a fine gathering of *Physarum penetrale* Rex. This was made in July in Dunston Woods, near Norwich. The beautiful rich orange-yellow colour of the immature sporangia made them more easily seen; in the greenish-grey ripe state they are not so readily noticed. A second gathering of this species was made a week later in the woods referred to at the beginning of this paper. In both cases the unripe sporangia were found on old bracken stems in the middle of a tall clump of growing brakes. Other records for *P. penetrale* are Luton, Beds. (Miss Higgins); Lisbon; near Paris (Dr. Ledoux Lebard); Jura Mountains; Switzerland (C. Meylan); Ohio; Knysna, Cape Province (Miss A. V. Duthrie).

Physarum lateritium (Berk. and Rav.) Morgan was another rarity (on dead wood at Dunston), which has only been recorded once before in Britain (by A. Camm, on holly-leaves at Smethwick, in Staffordshire). The only other European gathering recorded is the type of *P. Braunianum* De Bary; this was found on moss in Grünewald, near Berlin, in June, 1852, and, according to the second edition of the B.M. Monograph, it is questionable whether it should be placed with *P. virescens* or *P. lateritium*.

The plasmodium of the small Dunston gathering was orange-yellow, a fact not previously recorded. *P. lateritium* appears to be fairly common in the tropics, and Miss Lister informs me that of late years it has been also recorded from Chile and New Zealand.

Liceopsis lobata Torrend. This was also found at Dunston ; it has now been recorded from five British counties, Jura Mountains, Switzerland, the Pyrenees, and Portugal.

In conclusion, I should like to mention my great indebtedness to Miss G. Lister for her assistance in naming my Norfolk finds, and for her help in compiling these notes; lastly, but not least, for her never-failing encouragement in my study of this wonderful but little-known group.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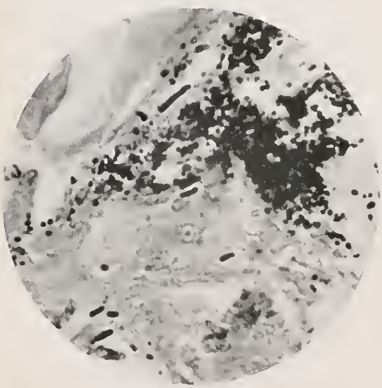
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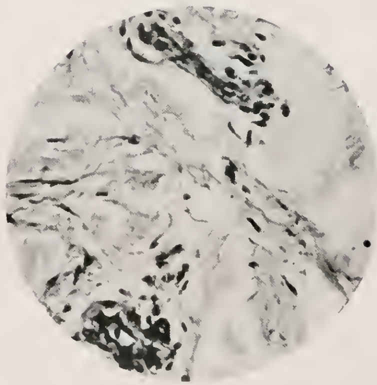
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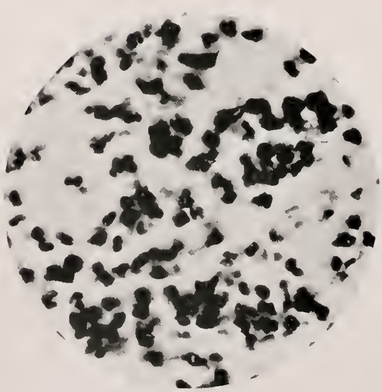
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IV.—*Bacteriology of Septic War Wounds.*

By K. W. Goadby.

Read March 21, 1917.

Plates XIX to XXII and 1 Text-Fig.

I do not this evening propose to enter into a controversial discussion of the medical technicalities involved in the bacteriology of the septic wound. What I do propose, with your indulgence, is to briefly outline some of the problems associated with the bacteriology and pathology with which we are daily confronted; to indicate to you the methods by means of which we are seeking to unravel these problems to combat bacterial ravages and promote the healing and return to health of our wounded soldiers.

In the practical working out of these problems I early found that new technical methods must be devised to deal with situations with which we were more or less unfamiliar, the septic wounds of war differing in divers ways from the injuries usually met with in civil practice. Chief amongst these differences are found to be (1) the large number of anaerobic bacteria met with in the majority of

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EXPLANATION OF PLATE XIX.

Fig. 2.—Pus-film from a septic wound, four days after injury. Commencing sporulation is seen, and almost complete disintegration of leucocytes. Stained Gram. × 1000.

,, 3.—End-sporing organism isolated from the same case; forty-eight hours' egg-agar. Stained Gram. × 1000.

,, 4.—Invasion of wounded tissue, showing mixed infection; material removed several weeks after original injury. Both cocci and Gram-positive bacilli (*B. perfringens*) were present; sporing anaerobes were also isolated. × 1000.

,, 5.—Granulation (partially organized) tissue from between fractured tibia and fibula, three months after original injury. The irregular loose loculi form spaces in which the original infecting organisms become sequestrated, and remain ready to take on fresh activity if the tissue is subsequently disturbed. Stained hæmatoxylin-eosin. × 500.

,, 6.—Section in the immediate neighbourhood of acute gas gangrene. A large number of organisms are seen, many of them situated inside the polymorphonuclear cells. Stained Gram-Weigert. × 500.

,, 7.—Section of tissue from the same situation as fig. 6, but stained hæmatoxylin-eosin, showing the polymorphonuclear activity; but this stain does not show the infecting bacteria. × 500.

wounds, such bacteria requiring the elimination of free oxygen in the cultivation technique; (2) the enormous number of bacteria of all sorts infecting the wounds, frequently with little or no constitutional disturbance to the patient; and (3) the wide-spread shattering of bone and muscle at long distances from the point of impact of the wounding missile, thereby depressing the vitality of the tissues and promoting bacterial invasion. All these three points I shall give illustrations of, and that I am enabled to do so is due to the painstaking and efficient work of your treasurer, Mr. Cyril Hill, who has collaborated with me in the technical department of photomicrography.

Photomicrography is not to be considered a mere adjunct, but rather an integral part of modern research in many fields of science, particularly in pathology and bacteriology, enabling accurate records to be made for future comparison, for tabulation, for demonstration and illustration. It is highly essential for such work to have not only good, or rather the best, apparatus, but to have a knowledge of the principles as well as the details of the apparatus used.

Before I proceed to the actual illustrations it will be more technically interesting to this Society to see some of the actual microscopical preparations from which the lantern-slides I shall subsequently show have been made, and I am enabled to do this by means of the optical bench recently acquired by this Society, which will project the actual microscopical specimens.

[A series of sections of wound tissue, showing the minute structure of the inflammatory processes following gunshot wounds, were projected, among them the actual specimens from which the photomicrographs Nos. 4, 6, 7, 8, 9, 10, 11, were made.]

I will indicate some of the difficulties experienced in obtaining our records, and, briefly, the methods of application of the records obtained.

Throughout the research Gram's stain has been used, with counter-staining by fuchsin, which gives an easily photographable colour to those organisms which stain by Gram's method, but the Gram-negative organisms with their red coloration are difficult to show on the same field.

In many of the specimens photographed egg-broth and mince-meat-broth were the medium used, and in these it is almost impossible to avoid a slightly stained background, greatly adding to the photographic difficulties. In the specimens of pus, Gram's stain gives no differentiation of the corpuscular elements, and the stain used was Giemsa's modification of Romanowski or Pappenheim's panoptic, both of which I have shown you in the microscopical projections. In the sections of tissue Gram-Weigert stain was used for the demonstration of bacteria, and hematoxylin-eosin for the cellular elements. In the tissue preparations it is extremely difficult to obtain sufficiently thin sections to allow of magnification × 1000.

To enable the exact spot chosen by myself to be found and photographed, recourse was had to the Maltwood finder. Two of these were kept in use.

For general purposes of comparison, and to facilitate reference, an album is kept of the silver-prints of the negatives, each print receiving the index-number and letter of the case corresponding to the serial card on which the records are kept in the bacteriological laboratory, the material also being cross-indexed.

General Methods of Investigation.

Wherever possible a radiograph of the wound is obtained as soon as possible after injury, and at appropriate intervals during its history. For these radiographs I wish to tender my thanks to my colleague, Dr. Berry, Radiologist to the Royal Herbert Hospital, Woolwich.

Cultivations, pus-films, and tissue-films were made as soon as practicable after the admission of the patient, the various species of aerobic and anaerobic bacteria plated out and examined. A similar procedure was carried out at any operation on the case, and, in addition, histological examination made of the tissues removed for identification of actual bacteria *in situ*, as well as the tissue reaction to the injury. By these methods it has been found possible to obtain a fairly complete history of the wound, including (1) general damage as seen by the naked eye; (2) the bacterial content of the wound; (3) the predominant bacterial infection in the superficial and deep parts of the wound; (4) the special tissue-changes caused by different species of bacteria; and (5) an evaluation of appropriate methods of treatment for the prevention of generalized infection, and the most rapid methods of obtaining a cure.

In many instances it has been possible to follow up individual cases, to watch bone-changes through the medium of radiographs, and to correlate these changes with the predominant bacterial flora; if, and when, a sequestrum formed and was removed, a careful bacterial analysis was made of the wound before and after the removal of the sequestrum.

Anaerobic bacteria were constantly found, especially in the sequestra removed at long intervals after the original wounding, and as this particular class of bacteria are met with in most war wounds, special forms of apparatus are required for their isolation and study.

Description of Anaerobic Apparatus (Text-fig, Fig. 1).

The apparatus used consists of a glass gas-jar, the lower part of which is filled with an inverted bottle and surrounded with small lengths of glass tube, and filled up with a 10-p.c. solution of pyrogallic acid in caustic potash to the level of the bottle. The lid is zinc, with a rubber washer, and kept in position by fly-nuts fixed to a broad brass trap encircling the upper part of the jar. Through the lid is screwed and soldered a brass T-piece; the ends of the T carry small pieces of rubber pressure-

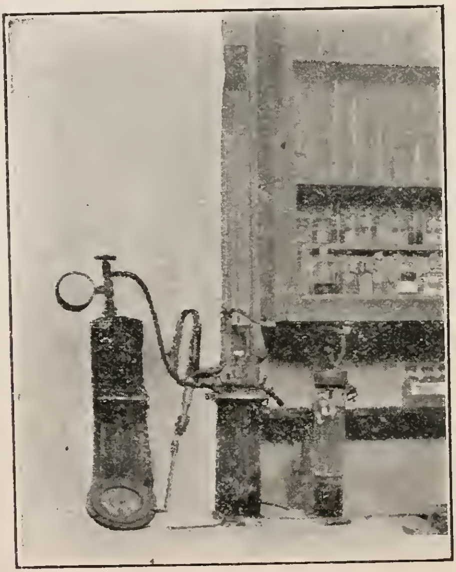

Fig. 1.

tube, which are clamped up with screw-clamps when the jar is exhausted. The plates or tubes, sown with the material containing anaerobic organisms, are placed in the jar, the lid firmly fixed with the fly-nuts, and the air exhausted with a water-pump, shown on the left side of the illustration; some time is allowed to elapse after the column of mercury in the manometer has reached its highest level (a perfect vacuum, of course, is not obtained by the water-pump, owing to the vapour tension of the water) to allow of the air dissolved in the media to be removed; when this is judged to have occurred, hydrogen is allowed to flow in from the cylinder, and, if necessary, the jar re-exhausted. Finally, the jar is filled with hydrogen, leaving a few centimetres of negative pressure, the screw-clamps closed, the jar detached from the pump and cylinder tubes and placed in the incubator.

The process is considerably accelerated if the tubes containing the media are boiled for half an hour previous to use. This form of apparatus has given the most satisfactory results in my hands, after an extended trial of many other methods. It is not very troublesome, and has the advantage of simplicity. To obviate the difficulty of condensation water on the surface of the agar, small oblong pieces of filter-paper are kept ready sterilized, and one placed under the lid of each plate before they are stacked in the jar.

Anaerobic Bacteria in Wounds.

I will now proceed to a demonstration of three cases in which a complete history will be shown photographically, commencing with a radiograph taken shortly after wounding, and completed by the radiograph taken when recovery had taken place. (The reproduction of these radiographs will be found in the paper by Dr. Berry, "Archives for Röntgen Rays," December, 1916.)

The amount of bacterial infection in a wound depends on many factors—the site of the body injured, the amount of clothing carried into the wound, the soil on which the fighting is taking place, and to a great extent also on the time that has elapsed before the wounded man has the parts cleansed and treated by skilled hands. The velocity of the modern projectile is such that in passing into or through human flesh and bone much minute microscopical damage is caused to the tissues at some distance from the actual wound, and if such a wound remain long unattended the dead tissue forms a pabalum upon which the microbes carried in by the projectile grow and flourish at an enormous rate. Fig. 2, Pl. XIX, is a pus-film from such a case; the wound, a compound comminuted fracture of the thigh, prevented the soldier, shot down in an advance, from obtaining skilled aid for twenty-four hours, during which time he lay in a shell-hole. This film was made on the third day after he was picked up—that is, four days after the actual injury. The pus is seen to contain a large variety of anaerobic bacteria as well as aerobic species. Among the bacillary forms are seen sporing organisms, and fig. 3, Pl. XIX, shows a pure culture of one of these organisms after careful plating and isolation in the anaerobic chamber. The pus obtained from a wound may perhaps at times not represent the actual state of tissue infection, for often the bacteria multiply in the pus itself, especially when the discharge from the wound is pent up; but, nevertheless, tissue infection is unfortunately only too common. Fig. 4, Pl. XIX, shows this tissue infection. The piece of muscle and bone from which this slide was made was obtained from a case of fracture of both bones of the forearm, and was removed a considerable time (many weeks) after the original injury. The mass of invading organisms is seen to consist of many types, among which are cocci and bacilli resembling *B. perfringens.* As the body tissues gradually overcome the infecting bacteria, the protective reaction of the tissues changes to one of repair, and loose fibrous tissue gradually repairs the deficiencies in the muscles and binds the whole injured part together, often in mal-position. In this fibrous meshwork (fig. 5, Pl. XIX) I have frequently found little pockets of bacteria entrenched in the new tissues, unable to grow and do any damage while they are locked up by the stroma woven around them, but nevertheless remaining like seeds in a state of suspended animation until some accident tears their prison walls—such, for instance, as massage, passive movements to a joint, or a subsequent operation—then they take on a new lease of life, and secondary suppuration supervenes.

My next series are slides illustrating gas gangrene.

Gas gangrene is a complication which may occur with dramatic suddenness in a wound, usually a severe shell wound, and is caused by an enormous and rapid development of certain anaerobic bacteria, which ferment the natural sugar (inosit and glycogen) always present in muscles with the formation of large quantities of gas. The gas formed blows up the tissues in all directions, and certain poisons manufactured by the bacteria at the same time poison and destroy the vitality of the part. So rapid is the disease in some cases that in a very few hours after wounding the whole

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EXPLANATION OF PLATE XX.

Fig. 8.—Transverse section of muscle in gas gangrene. The wide separation of the muscle bundles is caused by distention with gas; in the interspaces numerous organisms may be seen. Stained Gram. × 250.

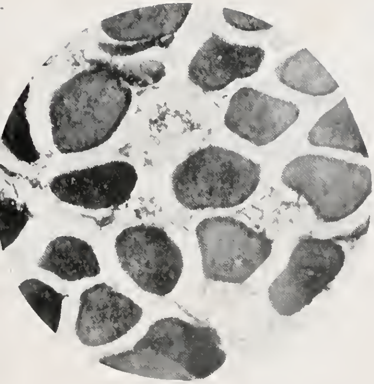
,, 9.—Pus-film from previous case, made at the time of operation, showing multiple infection of the original wound; spore-forming organisms of the clostridial type are seen. Stained Gram. × 1000.

,, 10.—Tissue removed at operation for spreading septic infection. The tissue structure has disappeared, but a mass of bacteria is seen attached to the walls of the small blood-vessel. Stained Gram-Weigert. × 1000.

,, 11.—Muscle section, showing infiltration with spore-forming anaerobes of the *B. œdematis maligni* type between muscle bundles and progressive digestion of muscle tissue. Stained Gram. × 1000.

,, 12.—Pus-film in later stages of healing gangrenous wound, showing activity of leucocytes; streptococci are present undergoing phagocytosis. × 1000.

,, 13.—Pus-film from similar case at a later stage, showing almost complete digestion of organisms in the interior of the leucocytes. The organisms have now lost their original shape, and are represented by small irregular black dots. Stained Gram. × 1000.



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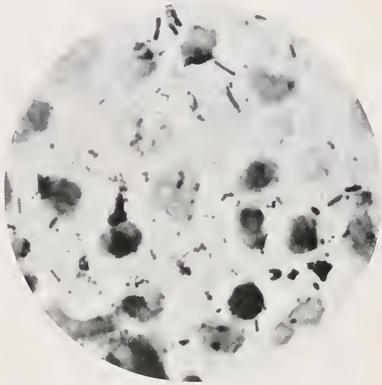

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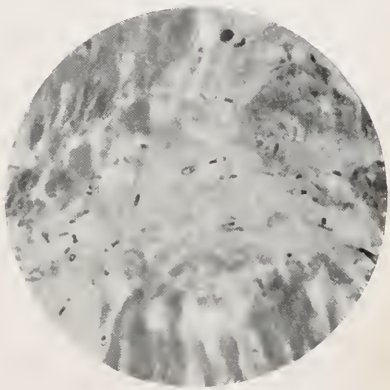

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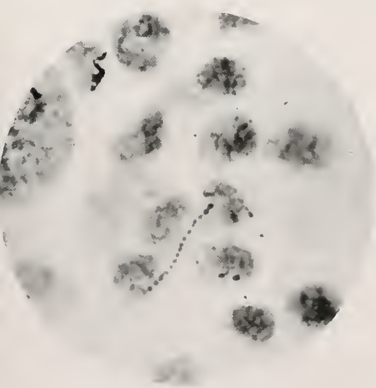

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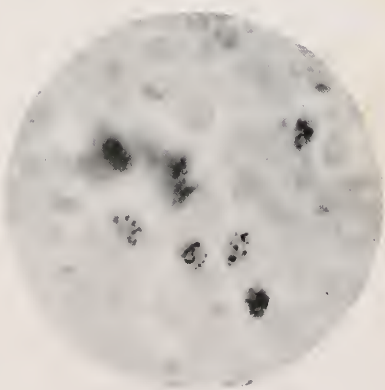

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limb is tense, crackles on pressure, and if the limb is incised a rush of gas takes place which, if lit with a match, lights with explosive violence. Such cases are rapidly fatal. In other cases the development of gas is delayed for many days, and then only appears slowly and insiduously; while in yet a third type of case the actual anaerobic bacilli which cause the gas may be found without any symptoms of gas gangrene appearing. Much of my attention has been directed to the elucidation of the causes underlying the development of this fell disease, and I have published the results * of an inquiry into this question, and have arrived at the conclusion that, in the cases which develop gas gangrene several days after wounding, there is a symbiosis with certain aerobic bacteria whose activities prepare the way for the microbes of gas gangrene by digesting the tissues and creating a fertile soil for their growth.

The radiograph of the actual limb from which my next illustration was taken showed a foreign body (a fragment of shrapnel) on the inner side of the tibia. Stretching from the foreign body was seen a long line of gas-infiltrated tissue. The slide (fig. 8) shows a section of a portion of this gas-infiltrated tissue with the muscle fibres widely separated. The case died suddenly from heart failure. Masses of organisms, *B. perfringens* and the aerobic *B. lactis ærogenes*, were obtained from the incised tissue both at operation and at the post-mortem.

Figs. 6 and 7, Pl. XIX, are from another similar case, in which acute gas gangrene occurred in both leg and arm; one, showing the organisms, was stained by Gram method, the other shows the cells in which the organisms were situated, and was stained by hæmatoxylin-eosin, which stain does not show the bacteria. This case also died of acute general toxæmia.

Figs. 9 and 10, Pl. XX, illustrate another case of gas gangrene, occurring in the shoulder-joint after severe injury. The pus-film shows the heavy infection (fig. 9, Pl. XX). Fig. 18, Pl. XXI, is a culture of *B. œdematis maligni* obtained from the case. Fig. 10, Pl. XX, is a portion of the tissue removed at operation, in which numerous organisms are scattered throughout the degenerating tissue. This man has made an excellent recovery. He was treated with vaccine immediately after admission, and the antisepsis vaccine continued for eight weeks.

Fig. 11, Pl. XX, is the muscle tissue of another case of gas gangrene, in which a foreign body (shrapnel fragment) was surrounded by an area of gas gangrene.

A previous illustration (fig. 6, Pl. XIX) also demonstrates that the body tissues under some circumstances attack and destroy

* The Lancet, July 15, 1916, Sept. 30, 1916, and Nov. 18, 1916; Proc. Roy. Soc. Med., x. No. 2, Dec. 1916.

B. perfringens, although in the gas-infiltrated area the cells are all destroyed. The normal process of bacterial destruction is carried out by the polymorphonuclear cells, and figs. 12 and 13, Pl. XX, made from the pus of a healing wound, show this process in action. Fig. 12 shows the various streptococci and other organisms in the interior of phagocytes, and fig. 13 actually shows the phagocized organisms partially digested. These two photographs were difficult ones to make; the films were stained with Pappenheim's panoptic stain, nevertheless the organisms as well as the cells are clearly seen, even the partially digested ones.

Figs. 14 and 15, Pl. XXI, are types of bacilli isolated from certain types of cases, and which so far are unidentified, as anaerobes are extremely difficult to differentiate owing to their curious method of growth; one of these organisms is probably Pasteur's *Vibrion septique.*

B. tetani is often found in septic wounds even when no symptoms of lockjaw appear; that clinical symptoms do not develop in such cases is no doubt due to the universal administration of antitetanus serum to every wounded man at the earliest possible moment after injury. Fig. 16, Pl. XXI, is a somewhat aberrant form of *B. tetani* obtained from one of the most acute cases of fatal tetanus I have met with; the cultures of the organism shown are highly toxic, in fact this particular culture is now used for the production of tetanus antitoxin.

The next series of slides illustrate the great advantage of photographic records in bacteriological research in maintaining visual records of variations in morphology of the different species of bacteria. Stained microscopical preparations are notoriously liable to fade, whereas a negative once obtained is a permanent record.

The anaerobic organisms here illustrated are divisible into three groups, having general biological peculiarities—

1. *B. œdematis maligni,* an energetic protein digestor.
2. *B. perfringens* (*B. welchii,* or *B. ærogenes capsulatus*), which

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EXPLANATION OF PLATE XXI.

Fig. 14.—Bacilli with clostridial spores oval and flattened; isolated from acute gas gangrene. Stained Gram. × 1000.

,, 15.—*B. perfringens* type, with long threads; isolated from acute gas gangrene. Stained Gram. × 1000.

,, 16.—Pure culture of *B. tetani*; agar, forty-eight hours. Atypical form and absence of typical "drumsticks." Stained Gram. × 1000.

,, 17.—*B. œdematis maligni,* subterminal end-spores with long thread formation; agar, forty-eight hours. Stained Gram. × 1000.

,, 18.—Ditto. Oval and subterminal end-spores; egg-agar, forty-eight hours. Stained Gram. × 1000.

,, 19.—*B. Hibler IX,* oval terminal end-spores; egg-agar, forty-eight hours. Stained Gram. × 1000.

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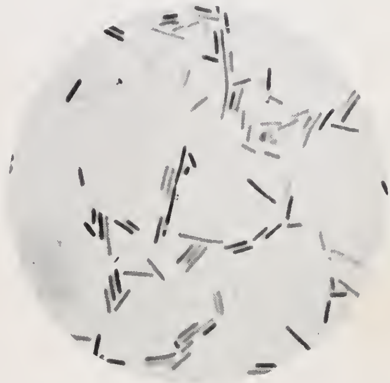

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attacks carbohydrates with avidity and is the chief cause of the gas which produces the symptoms of gas gangrene.

3. *B. Hibler IX* (*B. putrificus*), the cause of much of the factor of septic gunshot wounds.

Figs. 17 and 18, Pl. XXI, are types of malignant *œdema* group. The sporulation is subterminal and clostridial; very long threads often occur, and bacilli in chains (streptobacilli), the individual elements of which show variation in their reaction with Gram's stain. Fig. 18 is a pure culture from the case previously noted in which the pus showed heavy anaerobic infection. (Fig. 2, Pl. XIX.)

Fig. 19, Pl. XXI, is a very beautiful example of the sporulation of *B. Hibler IX*, showing spore formation in several stages. The form usually illustrated as *B. putrificus* exactly resembles the early sporulation of this organism. The spores when forming stain deeply with Gram's stain, giving a true drumstick appearance, at one time thought to be confined to *B. tetani*. When the spores are fully formed they are oval and often set at an angle with the organism, resembling an old-fashioned tennis racquet. The spores are oval and entirely terminal. I have not observed subterminal or mid-spores with this organism.

Figs. 20–25. Pl. XXII, are various phases of *B. perfringens*.

Fig. 20 shows a common appearance in broth in young cultures; small attached organisms are seen adhering to the bacillus. This organism is considerably altered by its environment; frequently quite small bacilli are observed, and many of the rods do not stain blue with Gram.

Fig. 21—when grown on serum for three days long threads are formed with curious involution forms, but no spores are seen; the organism now takes Gram's stain poorly, and exhibits a curious mottled or striated appearance not unlike the fragmentation of a streptothrix mycelium. When obtained from human fæces these

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EXPLANATION OF PLATE XXII.

Fig. 20.—*B. perfringens* (impure culture), showing attached organisms. Stained Gram. × 1000.

,, 21.—Ditto. Four days' serum agar; long and irregular thread-forms, with granular staining. Stained Gram. × 1000.

,, 22.—Ditto. Meat culture, forty-eight hours; showing numerous Gram-negative forms. Stained Gram. × 1000.

,, 23.—Ditto. From fæces (impure culture); thread-formation similar to that shown in fig. 21, but with less granular staining. Stained Gram. × 1000.

,, 24.—Ditto. Glucose formate agar culture, twenty-four hours. Stained Gram. × 1000.

,, 25.—Ditto. Three days' glucose formate agar; showing Gram granular staining, typically seen in milk culture and where carbohydrates are present. × 1000.

same long threads are also occasionally seen as in fig. 23; in this case the organism took the Gram's stain fairly well.

When grown on glucose formate agar, a medium especially congenial to this organism, the size of the rods is extreme (fig. 24), and the staining is very dark; later in two or three days the staining may become mottled or Gram granular (fig. 25), and this characteristic is seen in impure cultures made from wounds before plating out (fig. 22). All these three types of organisms are met with in septic wounds and tend to persist in the scattered fragments of bone and coarse granulation tissue (fig. 5, Pl. XIX) developing in the process of healing.

The series of slides I have shown more than prove my contention of the great advantage derived by the use of photomicrography in the prosecution of bacteriological research, more especially when so varied a series of problems presents itself for elucidation. From a technicological point of view—and it is mainly for this purpose that I have brought them to notice—this series of slides illustrating extremely varied subjects shows what may be accomplished by careful consideration of the optical problems involved—the use of the appropriate colour screens and standard methods of development and exposure which have been adopted throughout. A standard magnification of 1,000 diameters for the bacteria and 500 for the tissues and sections is used to enable exact comparison of individual slides. The methods of staining have also been standardized as far as possible, and much valuable knowledge has been obtained in the mere technique of staining by the close attention to the fact that the preparations were required for photography. All the technical details of the photography enumerated above have been carried out by Mr. Cyril Hill, to whom I tender my hearty thanks for his painstaking co-operation.

NOTE.

Technical Optics.

Arrangements have recently been completed for an important development in national industry on the scientific side by the establishment of a new Department of Technical Optics, in connexion with the Imperial College of Science and Technology at South Kensington. The department in question forms part of a larger scheme adopted by the London County Council in August last for the provision of instruction in this most important subject (in which the Council promised to find certain moneys for the scheme, if the Government also contributed), including post-graduate and research work at the Imperial College; a trade school and senior day and technical courses at the Northampton Institute; and junior technical courses at two junior technical institutions, one in North London and one in South London.

Since August last the Government, including the new Department of Scientific and Industrial Research and the Imperial College, have decided financially to support the Council's scheme, and all the necessary assents have been obtained. The amount of money immediately available is 4000*l.* a year for working expenses, and 5000*l.* for equipment and more immediate necessities of the department.

The new department is under the management of a Technical Optics Committee, of which the Right Hon. Arthur H. D. Acland is Chairman, and which at present consists of thirteen members, representing the Admiralty, the Army Council, the Ministry of Munitions, the Royal Society, the National Physical Laboratory, employers in the optical trades, glass manufacturers, and the Imperial College, while two further members have yet to be elected representative of glass-workers and metal-workers. The same Committee appointed by the L.C.C. is also an Advisory Committee to the Council.

Mr. Frederic J. Cheshire has been appointed head of the new department at the Imperial College for a period of five years, with the title of Director of Technical Optics, and Professor of Technical Optics at the Imperial College. Mr. Cheshire's long experience and great ability in optical matters practically ensure a successful beginning. He has been associated with optical instruments for many years at the Patent Office, and since the formation of the Ministry of Munitions has been Deputy Director-General of the

Ministry and Technical Director of the Optical Department of the Ministry. He is the present President of the Optical Society.

It is expected that, subject to the conclusion of certain arrangements with the Treasury, Mr. Cheshire will accept the Directorship; and it is anticipated that the organization of the department will be rapidly completed, and that training will begin at an early date.

SUMMARY OF CURRENT RESEARCHES

RELATING TO

ZOOLOGY AND BOTANY

(PRINCIPALLY INVERTEBRATA AND CRYPTOGAMIA),

MICROSCOPY, ETC.*

ZOOLOGY.

VERTEBRATA.

a. Embryology.†

Chromosomes of Human Spermatocytes.‡— H. L. Wiemann finds that the metaphase plates of human spermatogonia contain twenty-four straight or bent rod-shaped chromosomes, two of which are presumably idiochromosomes forming an XY-pair. Throughout the growth period of the primary spermatocyte, the idiochromosomes persist as a basic staining bipartite body whose components are sometimes separated, in which case there are two chromatin nucleoli in the nucleus instead of a single-paired one.

In the prophase of the primary spermatocyte twelve bivalent chromosomes appear, one of which is the XY-pair. The XY-pair divides longitudinally in the primary spermatocyte division. The remaining eleven bivalent chromosomes also divide in this division, but whether quantitatively or qualitatively was not determined. An interkinesis stage follows in which the nucleus contains a double chromatin body resembling the chromatin nucleolus of the first spermatocyte. It is suggested that this body is one-half of the longitudinally split XY-pair of idiochromosomes which persist throughout the interkinesis stage.

The second spermatocyte metaphase plates contain twelve chromosomes, one of which can be recognized as a half of the split XY-pair. In the division it is assumed that the X- and Y- constituents pass undivided to opposite poles, while the remaining eleven chromosomes all

* The Society are not intended to be denoted by the editorial "we," and they do not hold themselves responsible for the views of the authors of the papers noted, nor for any claim to novelty or otherwise made by them. The object of this part of the Journal is to present a summary of the papers *as actually published*, and to describe and illustrate Instruments, Apparatus, etc., which are either new or have not been previously described in this country.

† This section includes not only papers relating to Embryology properly so called, but also those dealing with Evolution, Development, Reproduction, and allied subjects.

‡ Amer. Journ. Anat., xxi. (1917) pp. 1–20 (4 pls.).

divide. The result would be that one-half of the spermatids receive leven' ordinary chromosomes plus X, and the other half eleven plus Y. The number and behaviour of the chromosomes in the spermatogenesis of the white and negro races of man is the same in the material studied.

Effect of Alcohol on Germ-cells.*—Raymond Pearl has experimented with domestic fowls in order to determine whether the continued administration of ethyl-alcohol (or similar narcotic poisons) effects precise and specific changes in the germinal material, such as to lead to new, heritable, somatic variations. The fowls were subjected to ethyl-alcohol, methyl-alcohol, or ether in inhalation tanks. The treatment extended over an hour each day, for 130–354 days, with a mean of about seven months. The males used were pure-bred Black Hamburgs, the females pure-bred Plymouth Rocks. Full brothers and sisters of the "treated" birds were used as controls.

The results show that "the treated animals themselves are not conspicuously worse or better than their untreated control sisters or brothers. The survivors, i.e. those not killed by accident, after roughly a year and a half of daily treatment, are becoming a bit too fat for their best physiological œconomy, but except for that point, and the reduced activity which goes with it, they are very much like normal fowls."

The mortality among the treated birds was much smaller than among their untreated control sisters. But the numbers involved were small. Immediately after treatment began there was an increase in body weight, probably not due to the treatment; then there was a sharp and prolonged fall; then there was a steady rise. At the end of the experiments the treated birds were on the average 9·9 p.c. heavier than their untreated sisters. Neither the total amount nor the distribution of egg-production were significantly different in the two sets of birds. Both treated birds and control birds laid normally and well.

Origin of Germ-cells in Chick.†—Franklin P. Reagan supports the conclusion of Swift that the germ-cells originate in a crescent-shaped area of the extra-embryonic blastoderm of the chick, anterior to the body-axis at the line of demarcation between the areas pellucida and opaca; and that these primitive germ-cells reach the gonad partly by their own wandering, but principally by way of the blood-stream which transports them either to the gonad where they continue to develop, or to some other region where they soon degenerate. In any case, the extra-regional origin of the germ-cells of the chick is highly probable, and some experiments have been begun by Reagan on very early embryonic castration (by removal of the germ-tract on the yolk-sac). The artificial production of embryonic hermaphroditism is also suggested.

Ovarian Cycle in Mice.‡—H. P. Smith, who with Dr. J. A. Long made a study, extending over ninety-one days, of the ovulation cycle in

* Journ. Exper. Zool., xxi. (1917) pp. 125-64 (3 figs.), and pp. 165-86 (4 figs.).
† Anat. Record, xi. (1916) pp. 251-67 (4 pls.).
‡ Anat. Record, ii. (1917) pp. 407-10.

mice, has now continued his work in order to examine a greater number of cases within twenty-two days after parturition, and thus detect variations in the time of occurrence of ovulation. Fifty-two cases are tabulated. One ovulation follows very quickly on parturition, another in sixteen and a half to nineteen days, or, on an average, a few hours less than seventeen days after the first spontaneous ovulation. But this was only shown by 42 p.c. of cases, and considerable individual variation appears to exist. The ovum of the mouse occupies approximately two days in traversing the greater part of the oviduct, but it waits in the last loop for a day or more, so that three days must be reckoned for the complete migration.

New Protamines from Milt.*—Makoto Yamagawa has isolated a number of new protamines from the sperm of Japanese fishes. Their properties are analogous to those of previously known protamines. Arginine is the chief product of the hydrolysis of the new protamines; its percentage is generally lower than in previously known protamines. Injection of the protamines produces toxic effects on mice, guinea-pigs, rabbits, and dogs. Their injection into the circulatory system of rabbits and dogs is followed by a considerable lowering of the blood-pressure. They seem to cause the dilatation of blood-vessels, and to hinder or delay the coagulation of blood.

Inequality of the Testes in Pigeons.†—Oscar Riddle refers to the prevalence of atrophy of the right ovary in birds, the demonstrated larger number of primordial cells in the left gonad in the fowl, and the unequal size relations of the testes in the pigeon (where the right is usually the larger). In hybrid pigeons there are more exceptions to the normal size-relations of the two testes than in pure species. The number of the exceptions seems to increase with the degree of hybridization (width of the cross), there being fewer in specific than in generic hybrids. The testes of pigeons suffer great reduction in size in disease —particularly in tuberculosis. It is probable that the right suffers greater reduction than the left. The testes of the pigeons are characteristically different in dimensions, the left being thinner and more elongate, the right shorter and thicker.

Blastolytic Origin of Independent Lenses.‡—E. I. Werber has studied the free or independent lenses seen in teratophthalmic specimens of the fish *Fundulus heteroclitus*. Lenses develop without contact stimulus from an optic cup, from indifferent ectoderm which would normally not have given rise to such structures. The teratophthalmia is associated with blastolysis, a dissociation of parts of the blastoderm. In other words, the formation of terata of the eye comes about through destruction of parts intermediate to the earliest primordia of the eyes or of parts of the eyes. The development of the free lenses is due to

* Journ. College Agric. Univ. Tokyo, v. (1916) pp. 413–59.
† Anat. Record., xi. (1916) pp. 87–102.
‡ Journ. Exper. Zool., xxi. (1916) pp. 347–67 (2 pls. and 2 figs.).

dispersed ophthalmoblastic material. It may be that indifferent ectoderm is stimulated by a fragment of ophthalmoblastic material too small to differentiate into a morphologically discernible structure. It may be that blastolyzed potential optic cup substance exerts a "lentogenic" stimulus on the ectoderm which is of the nature of a catalytic reaction.

Development of Vascular System in Reptiles.*—Chas. H. O'Donoghue finds that three of the six embryonic arches persist in the adult reptile, and of their connecting vessels both ductus carotici and ductus arteriosi may persist or be represented by ligamenta. In *Sphenodon* both ductus are to be found on each side. In Chelonia the ductus carotici are usually absent, while the ductus Botalli remain. In Crocodilia the ductus carotici are probably not usually present, and the ductus Botalli may probably remain. In Lacertilia the ductus carotici are present very generally, although in some species reduced or absent, and the ductus Botalli are always reduced and very often absent. In Ophidia the ductus carotici are normally absent, but the ductus Botalli persist, and often on both sides, in spite of the suppression of one lung and pulmonary artery. There seems little doubt that the main factor affecting the persistence or loss of these structures is the change undergone in the relative positions of the heart and arterial arches in the course of development and subsequent growth.

Sex of Parthenogenetically-developed Frogs.†—Jacques Loeb refers to seven specimens of *Rana pipiens* over a year old, which developed from unfertilized eggs. These eggs were pricked (after the experiments of Guyer and Bataillon) with a needle that had been dipped in blood. The young frogs were normal in growth and behaviour, and a photograph is submitted of one which was killed at the age of ten months. Some time ago Loeb and Bancroft inquired into the sex of such parthenogenetically-developed tadpoles and frogs, but met with the difficulty that ova persist for four months or so in the male gonads. The ova were so few, however, that it seemed safe to conclude that the young forms would have developed into normal males. Loeb has now examined the testis of the ten months' old young frog and finds it normal, with numerous spermatozoa. It would appear that in the frog the male is heterozygous for sex, i.e. that the eggs are all alike and that there are two kinds of spermatozoa, one with and one without a sex-chromosome; and that if a spermatozoon of the former type enters an egg a female is produced. Another young frog, of similar origin, which died at the age of thirteen months, proved to be a male. It had swollen first fingers.

Seminiferous Tubules of Birds.‡—G. Carl Huber finds that these are arranged in the form of a network, presenting a varying number of anastomoses found at different levels in the gland substance. Teased

* Journ. Anat., li. (1916) pp. 137–49 (5 figs.).
† Proc. Nat. Acad. Sci., ii. (1916) pp. 313–7 (2 figs.).
‡ Anat. Record, xi. (1916) pp. 177–80 (1 pl.).

preparations show closed ring structures. In the tubules of the adult mammalian testis, completely teased, no blind endings, buds, nor ring formations were observed. In a cryptorchid of the rabbit, as described by Huber and Curtis, extended anastomoses of testis tubules were observed in two regions of the tubule complex, and in two regions, near the periphery of the gland, tubules were joined so as to form two folded rings. The preparations from the cryptorchid of the rabbit present appearances not unlike those shown in teased preparations of the seminiferous tubules of the bird. The presence of the remains of the embryonic network of the seminiferous tubules in the cryptorchid of the rabbit and in the bird's testis, postulates a relatively late complete morphogenesis of the seminiferous tubules of the mammal. Phylogeny and ontogeny indicate this.

Age and Fertility in Rats.*—Helen Dean King has studied the litter data of 76 female rats, extracted strains derived from the second filial generation of a cross between the wild Norway rat and the domesticated albino. The material comprises the data for 585 litters, including 2036 males and 1919 females. The average number in each litter was 6·7. Fertility in the rat, measured by the total number of litters cast, increases with the age of the female rat up to seven months, the climax of reproductive activity. There is a sharp decline after the female is a year old, and the menopause appears at eighteen months. The age influences the size of the litter. The average number of litters is 7·7 per female. The sex ratio for 3955 individuals was 106·1 males to 100 females. The age of the mother does not seem to be a dominant factor in determining the sex of her offspring, but old females seem to produce relatively more female than male offspring.

History of Eye Muscles.†—H. V. Neal has sought to demonstrate, on the basis of embryological evidence, the exact homology of the first three permanent myotomes of *Amphioxus*, *Petromyzon* and *Squalus*. He maintains, with Dohrn, that the second as well as the third myotome participates in the formation of the external rectus muscle. He suggests that the text-book formula for the ontogenesis of the eye-muscle should be read thus: From the first myotome (pre-mandibular head-cavity) arise the muscles innervated by the oculo-motor. From the second myotome (mandibular head-cavity) develop the obliquus superior and the ventro-lateral portion of the M. rectus externus. From the third myotome (hyoid head-cavity) arises the dorso-median portion of the rectus externus muscle.

Rare Form of Double Monstrosity.‡—James F. Gemmill and James Stewart describe a "Siamese Twin" omphalopagous human monstrosity which (with one doubtful exception) appears to be of a unique type. The peculiarity is that the union is confined to the

* Anat. Record, xi. (1916) pp. 269–87 (3 figs.).
† Anat. Record, ii. (1917) pp. 391.
‡ Journ. Anat. Physiol., l. (1916) pp. 316–23 (4 figs.).

umbilical region, leaving the skeletal structures of both sternum and pelvis entirely unconnected with one another. The union was exactly face to face, except for the fact that the umbilical cord is single and comes off from one side of the central mass. The omphalopagous type of monstrosity finds its best illustration among the osseous fishes. In trout and salmon, for instance, union of symmetrical twins by the yolk-sac only is by no means uncommon, as Gemmill has shown. In rare cases survival for a time may occur. As Geoffrey Saint-Hilaire pointed out, omphalopagous union can readily occur wherever the egg is large and the yolk-sac is not cast off but taken into the body. In reference to the human case described, the twins are uni-oval in origin. The germinal areas from which they developed were probably situated opposite one another on the wall of the blastocyst. There may have been only one endodermic sac, but more probably there were two such sacs which became confluent posteriorly on their ventral aspects.

Prolonged Gestation in Suckling Mice.* — W. B. Kirkman has inquired into the lengthening out of the gestation period, when the females suckle their young during pregnancy. He has brought together data from which it is possible to determine, within the possible error of one day, the age of all embryos obtained from non-suckling white mice. Ovulation, fertilization, and the early cleavage of the eggs bear the same time relations to parturition and to one another in both suckling and non-suckling white mice, except that the former are much more apt to skip an ovulation period.

Implantation of embryos in the uterus occurs in non-suckling white mice on the fifth day following parturition (provided the female did not skip an ovulation cycle). Implantation of embryos in the uterus occurs in suckling white mice, with three or more young, on the fourteenth day following parturition (provided the female did not skip an ovulation cycle). In these lactating females the blastulæ lie free in the lumen of the uterus from the sixth to the fourteenth day post-partum. This is supposed to be due to the activity of the mammary glands.

The available material of stages following implantation in suckling females shows no evident correlation with either the number of nursing young or the number of embryos being carried. It is also impossible at present to reconcile the development of these embryos with the observed facts regarding the time of parturition in suckling mice.

Effect of Extirpating Hypophysis on Growth and Development of Frog.† — P. E. Smith finds that the removal of the hypophysis makes the growth of tadpoles slower than the normal. The hypophysectomized specimens were perhaps more alert than the checks; they were more resistant to a disease which attacked both them and the others. They were much lighter in colour, there being fewer melanophores and fewer melanin granules in them. The growth of the hind legs was greatly inhibited; in most cases there was no growth of the buds of the hind

* Anat. Record, xi. (1916) pp. 31–40.
† Anat. Record, xi. (1916) pp. 57–64 (10 figs.).

limb after their first appearance. There were striking differences in the endocrine glands, but no constant variation from the normal was observed in the gonads.

Influence of Diet of Ductless Glands.*—E. R. Hoskins finds that thyroid feeding causes little or no change in the body-weight of growing albino rats. It produces decided hypertrophy of heart, liver, spleen, kidneys, and suprarenal bodies (especially in males). Thymus feeding has no apparent effect on the growth rate of the body. Nor did feeding with hypophysis or with pineal body make any apparent change. Many detailed results are communicated.

Undersized New-born Rats.†—Helen Dean King discusses the occurrence of undersized and abnormally light new-born mammals, which breeders call "runts," and discard from breeding. A litter of rats may contain individuals of three kinds as regards their inherent capacity for body-growth. As a rule all are normal. Occasionally some have a very small birth-weight, but recover from this. If a litter is very large, or if the mother is not in good physical condition during the gestation period, some of her young may be born with their growth capacity so impaired that it is impossible for them to grow beyond a certain stage. These individuals are true "runts." They tend to have an abnormally small nervous system when they become mature. They are lacking in reproductive vigour, so that they are usually unable to reproduce their kind, and so prove a menace to the colony in which they live.

Origin of Osteoclasts.‡—L. B. Arey has followed up and extended the investigation left unfinished at the death of Professor C. W. Prentiss, on the origin and fate of the osteoclasts. These may arise in the earlier stages of development from the reticular cells of the marrow; in later stages they are formed from sycytia of exhausted osteoblasts. The numerous nuclei of large osteoclasts are derived: (*a*) from the constituent osteoblasts, and (*b*) from bone-cells which are ingested as the bone-matrix is re-absorbed. There is no direct evidence that the osteoclasts are the active agents in bone-resorption; they may also be interpreted as degenerating osteoblasts. Eventually the osteoclasts either atrophy and disappear, or are resolved into the reticulum of bone-marrow.

Origin of Vascular Endothelium and of Erythrocytes.§—Franklin Pearce Reagan has made experimental studies on embryos of chick and teleosts. One view is that the earliest vascular tissue appears on the yolk-sac (as an angioblast primordium), and grows towards the embryo. On reaching the embryo's body the vascular tissues permeate the intra-embryonic tissues in a centrifugal manner, forming the entire lining of

* Journ. Exper. Zool., xxi. (1916) pp. 295–346 (4 charts).
† Anat. Record, xi. (1916) pp. 41–52.
‡ Anat. Record, ii. (1917) pp. 319–22.
§ Amer. Journ. Anat., xxi. (1917) pp. 39–174 (22 pls.).

the hæmal and lymphatic systems. The view opposed to the angioblast theory is that of local origin. According to this view, mesenchyme may, in practically any region of the body, transform into vascular tissue.

Reagan's results furnish evidence in favour of the following propositions:—1. That mesenchyme in many regions of the body can turn into endothelium, and that endothelium is not an ingrowth from vessels on the yolk. 2. That prevascular tissue can come from more than one germ-layer. 3. That mesenchyme cells which can form a given type of blood-cell are not confined to a narrowly limited region of the embryo. 4. That endothelium can transform into blood-cells.

Internal Secretion.*—J. F. Gudernatsch, continuing his studies on internal secretion, describes a set of experiments undertaken to study the influence on the development of tadpoles of several distinct constituents of the thyroid and thymus. By a detailed chemical procedure each organ was split into seven products, all in aqueous solutions. The nitrogen content of the various solutions was determined, and the same concentration used for each set of tadpoles. The constituents are arranged in a series showing their influence on differentiation and on growth. In general the serial arrangement of the thymus products is almost the opposite of the thyroid series, but it was not found that the corresponding constituents of the two glands were most active in counteracting each other. Older animals react more rapidly to the thyroid treatment than younger animals. The thyroid as a whole, and some of its constituents, proved the most powerful stimulus to differentiation, while growth was suppressed almost entirely. Only two of the thymus products delayed differentiation to any considerable extent. A complete set of growth curves is not given.

b. Histology.

Golgi Apparatus in Cells.†—Alwin M. Pappenheimer has studied a great variety of cells and finds the Golgi apparatus everywhere. It is a cytoplasmic structure of considerable complexity and size, demonstrable by prolonged fixation in osmic acid, or by silver impregnation and reduction. It includes a lipoid component. It is invisible in the living cell. Whether it is canalicular or filamentous remains uncertain. The constant topography and the relation to the cytocentrum would favour the idea of solid or semi-solid consistence.

Sensory Elements in Human Hypophysis.‡—W. Sohier Bryant has found sensory elements in maculæ on the posterior wall of the pituitary cavity, and sometimes, apparently, on the anterior wall. The maculæ are composed of tall columnar ciliated sensory cells interspersed with bipolar cells, which have their nuclei towards the periphery;

* Anat. Record, ii. (1917) pp. 357–9.
† Anat. Record, xi. (1916) pp. 107–48 (22 figs.).
‡ Anat. Record, xi. (1916) pp. 25–7 (1 fig.).

whereas in the ciliated cells the nuclei are near the base which terminates in a caudal prolongation. Between these caudal processes of the ciliated cells there is a layer of round cells, resting on a thin basement membrane. An area of ciliated cuboidal cells occurs at the margins of the maculæ.

Eye of Blanius cinereus.*—A. Menacho has made a detailed study of the eye of this Amphisbænid lizard. The eye is deeply hidden. There is a conjunctival sac, lined by a single layer of cylindrical epithelium. It receives the secretion of the orbital glands. The Harderian gland is greatly developed. There are no muscles moving the eye. The sclerotic has an incomplete cartilaginous ring. There is no true cornea, nor anterior chamber, nor ciliary muscles. The lens shows much degeneration; there is no cellular structure or only a few nuclei. The retina is very embryonic, showing, like the sclerotic, arrested development. There is no vitreous humour. There is no confirmation of Eigenmann's view that the most active parts are the first to degenerate; thus the lens and the vitreous humour cannot be called active.

Course of Vagus Branches on the Stomach.†—Einer Perman has studied the minute details of the branching of the vagus on the wall of the stomach in man. Between the ramification and the main stem there is no such plexus as is described under the names of anterior and posterior gastric plexus. Each vagus nerve gives off in the cardiac region a number of branches, of which five to seven pass directly into the longitudinal part of the stomach, while a very strong branch passes through the omentum minus to the transverse part. The further branching is carefully described. There is no sub-serous ganglion-plexus.

Structure of Fish-scales.‡—N. Rosén distinguishes in the making of scales two kinds of elements—namely, teeth and sclerosed plates in the corium. The plate consists of an outer, homogeneous layer, due to the outer layer of the corium, and an inner, fibrillar layer, due to the inner layer of the corium.

Three chief types of scales may be distinguished. 1. The scale may consist of a tooth only, as is the case in the fossil Cœlolepidæ, and may perhaps be the case in some Selachians. 2. The scale may consist of a plate (with an outer homogeneous and an inner fibrillar layer) which bears a tooth or several teeth. The plate may be penetrated by a system of canals and cavities, in which blood-vessels and nerves extend to the outer corium layer and the pulp of the tooth portion. This type is represented by the placoid scales of Selachians (with one tooth on each slightly developed plate), and by the *Lepidosteus* scales (with several, usually small, sometimes deciduous teeth and with a well-developed plate). 3. The scale may consist of a plate as before, but

* Trabajos Mus. Nacional Ciencias Naturales Madrid. Serie Zoologica, No. 21 (1915) pp. 1–48 (6 pls.).
† Arkiv f. Zool., x. (1916) No. 11, pp. 1–37 (9 figs.).
‡ Arkiv f. Zool., x. (1916) No. 7, pp. 1–36 (1 pl. and 13 figs.).

without teeth. This type includes shield-like scales (as in sturgeon, *Palæoniscus*, and some Plectognaths); spine-like scales (as in the lumpsucker); and the familiar cycloid and ctenoid scales. The tooth scale is oldest, the placoid next. Gradually the importance of the plate-portion increased and that of the tooth-portion decreased. It is possible to bring the numerous different types of scales into a genetic series.

Structure of Elastic Intima of Arteries.*—G. Carl Huber finds that the stainable substance of this layer consists of a network of yellow elastic fibres, with the coarser fibres having in the main a course parallel to the long axis of the vessel. These fibres present frequent anastomoses and cross bridges. There are also finer fibrils pervading the network. Here and there certain fibres of the intima may in cross or oblique sections be traced in anastomosis with elastic fibres of the media. The term fenestrated membrane is inappropriate and should be discarded.

Bone Architecture.†—J. C. Koch has undertaken exact mechanical analysis of the structure, external and internal, of the normal whole femur, with a few to the determination of the relations between structure and function at every point. He believes that the evidence warrants the following conclusions:—The normal external form and internal architecture of the human femur results from an adaptation of form to function. The proportions of the femur are everywhere such as to show a definite mathematical relationship between the body-weight and the internal structure of the bone; there is a definite relation between the structure and the stresses at every section. Spongy bone is homogeneous with compact bone as a structural material, and differs from it mechanically only in possessing smaller strength, approximately in proportion to its relative density compared with compact bone. The structure of the femur is based upon the mathematical requirements of mechanics, and the inner architecture is such as to produce great strength with a relatively small amount of material; the material is arranged to correspond with the stress requirements existing at every section. The adaptation of form to function proved mathematically for the normal human femur is the general law of normal bone. The thickness and closeness of spacing of trabeculæ in bone varies directly with the intensity of the stresses transmitted by them.

c. General.

Absorption from Serous Cavities.‡—P. G. Shipley and R. S. Cunningham have studied the passage of foreign fluids through the walls of blood-vessels and lymphatic vessels. Histological preparations show very active absorption of foreign fluids through the peritoneal blood-vessels. In all probability fluids may be removed from the peritoneal cavity through any area in which blood or lymphatic vessels

* Anat. Record, xi. (1916) pp. 169–75 (1 fig.).
† Anat. Record, ii. (1917) pp. 383–5.
‡ Anat. Record, xi. (1916) pp. 181–90.

lie just beneath the peritoneal surface. The material demonstrates that while some fluid may pass between the lining cells of vessels on its way to their lumen, by far the greater part goes through the cytoplasm of the cells themselves.

INVERTEBRATA.

Mollusca.

γ. Gastropoda.

Mollusca from Elevated Marine Beds of McMurdo Sound.*—Charles Hedley reports on a collection of shells, mostly of small size, collected on Sir Ernest Shackleton's Expedition from elevated marine beds, "raised beaches," of McMurdo Sound. There are twenty-one Gastropods and eight Lamellibranchs, and the Gastropods include three new species, which are described, *Turbonilla polaris*, *Trophon priestleyi*, and *Retusa frigida*.

δ. Lamellibranchiata.

Artificial Parthenogenesis in Cumingia.†—Margaret Morris has made a cytological study of artificial parthenogenesis in the mollusc *Cumingia tellinoides*. The process was induced by exposing the eggs to temperatures ranging from 32–37° C., and then to hypertonic sea-water. The highest percentages of cleavage-stages and swimming larvæ are obtained when the eggs are exposed to 32° C. for an hour. The highest percentage of polar body formation is obtained when they are exposed to 37° C. for one and a half minutes. By isolating eggs without polar bodies and observing their development, it was found that they may form fairly normal swimming larvæ. Those with polar bodies form non-cellular embryos, if they develop at all.

Cytological study of eggs which have not formed polar bodies shows that the chromosomes of the first polar spindle divide, and two nuclei are formed which fuse to form a cleavage nucleus. In the cleavage of these eggs there are fifty or sixty small rods of chromatin, instead of the thirty-six threads found in the normal egg. Cleavage often follows the normal pattern very closely. The chromosomes of the second polar spindle may also divide and form two nuclei which fuse. Very few of the eggs with one polar body divide. Eggs with two polar bodies may, in rare instances, divide once or twice. Eighteen chromosomes (the haploid number) are found in such eggs.

Maturation and Development in Cumingia Egg.‡—L. V. Heilbrunn describes some experiments in inducing maturation and initiating development artificially in the egg of the mollusc *Cumingia*. The egg is immature when shed into the sea, and it remains so unless it is fertilized. Soon after the entrance of the sperm the first polar body is

* Reports Sci. Invest. Brit. Antarc. Exped. 1907–9, Geology, ii. (1917) pp. 85–8 (3 figs.).

† Journ. Exper. Zool., xxii. (1917) pp. 1–51 (8 pls. and 4 figs.).

‡ Anat. Record, ii. (1917) p. 362.

given off. Polar body formation can be induced in three ways: by lowering the surface tension of the vitelline membrane so that it rises from the egg; by causing the vitelline membrane to absorb water and swell; and by shaking or rupturing it. In all three cases the stiff vitelline membrane is replaced by a more plastic film. Although the formation of the polar body can readily be induced in any of these ways, segmentation, in the great majority of cases, does not follow. As in the sea-urchin egg, a gelatinization or coagulation can be demonstrated to precede segmentation. In the *Cumingia* egg, cortical change stimulates to maturation, whereas in the sea-urchin egg the maturation process has been completed before the egg is fertilized.

Absorption of Nutriment from Solution by Mussels.*—E. P. Churchill, jun., has made a series of observations on fresh-water mussels in order to test Pütter's theory that animals living in water can use, in addition to "formed" food, nutriment which is in solution. He wished also to test Pütter's assumption that some of such nutriment is absorbed directly by the cells of the outer body-wall, especially by the gills.

His results show that mussels can make use of some kinds of food which are in solution in the water. A part, probably a small one, of such nutriment can be taken up directly by the outer epithelial cells of the body.

The dissolved nutriment taken up by the alimentary canal of the mussels was no doubt absorbed in the ordinary way. Numerous droplets of fat were found closely attached to outer ends of the epithelial cells of the gills or mantle. The absorption may be effected by phagocytic or amœboid action of the cells, or by solution in the plasma membrane and re-precipitation within the cell.

In regard to the absorption of albumin it is necessary to assume either a power on the part of the cell to split the protein into its amino-acids and the absorption of these as in the alimentary canal, or the direct taking in by the cells of the colloidal particles of albumin by means of something analogous to phagocytic action. In the case of starch it seems probable also that the granules entered by amœboid or phagocytic action.

What the author emphasizes is his proof that nutriment in dissolved form can be used. It is probable that the water in which the mussels normally live contains considerable quantities of solutions or colloidal suspensions of protemaceous material.

Arthropoda.

α. Insecta.

Metamerism of Insect's Body.†—Charles Janet has made many contributions to the question of the metameric architecture of the insect's body, and he sums up his conclusions, arranging the various segments in "triads" or groups of three. The first or stomenteric

* Journ. Exper. Zool., xxi. (1916) pp. 403–24 (2 pls.).
† Bull. Soc. Entomol. Suisse, xii. (1915) pp. 354–67 (1 pl.).

triad includes the proventricular, the œsophageal, and the supra-pharyngeal-clypeal metameres. The second or cerebral triad includes the protocerebral, labral, or ocular, the deutocerebral or antennary, and the tritocerebral, infra-pharyngeal, or post-antennary metameres. The third or gnathal triad includes the protognathal or mandibular, the deutognathal or maxillary, and the tritognathal or labial metameres. The fourth or thoracic triad includes the prothoracic, mesothoracic, and metathoracic metameres. The fifth triad or first abdominal corresponds to the petiolar area of Myrmicidæ, and includes the median metamere of Hymenoptera, the petiolar of ants, and the post-petiolar of Myrmicidæ. The sixth triad is the so-called gaster of Myrmicidæ, and includes the fourth, fifth and sixth abdominal metameres. The seventh triad is the female genital area, including the metamere with the female genital aperture, the metamere with the anterior gonapophyses, and the metamere with the posterior gonapophyses. The eighth triad is the male genital area, including the metamere with the penis of Hymenoptera, the metamere with the lateral cerci of Apterygota, and the metamere with the unpaired cercus of Apterygota. The ninth or proctenteric triad, includes the anal, rectal and intestinal metameres.

Duration of Life and Temperature Coefficient in Drosophila.*
Jacques Loeb and J. H. Northop raise the question whether there is a definite coefficient for the duration of life. This might be expected if the duration of life depended upon the presence of certain substances which are used up during life, or if the duration of life were limited by the cumulative injurious effects of certain products of metabolism. Experiments with *Drosophila* showed a temperature coefficient for the duration of life of about the order of magnitude of that of chemical reactions, namely, of about two for a difference of 10° C. At 28° C. the duration of life in days was 2·4 where the flies were provided only with water, and 7·2 when they were provided with a 1 p.c. cane-sugar solution; at 90° C. the corresponding figures were 4·1 days and 12·3 days.

Nutrition of Insects †—Jacques Loeb and J. H. Northop discuss the question whether the evolution of animals as high in the scale of life as insects was possible without the existence of green plants. Loeb has found that sterile culture media like those used by Pasteur for the raising of yeast were also sufficient for the raising of flies (*Drosophila*). But the question arose whether the flies might not be carriers of micro-organisms which synthesized the proteins for them. It was found that sterilized flies could not survive in culture media of casein, edestin, egg-albumin, milk, and the like. Moreover, flies free from yeast, when raised on sterile bananas or sterile potatoes were also sexually sterile. Yeast seems to be indispensable. Yeast must contain some substance required for the growth of the flies. They can live on any culture medium which can serve as a food for the yeast. They probably infect the food with the yeast. The experiments show that in

* Proc. Nat. Acad. Sci., ii. (1916) pp. 456–7.
† Journ. Biol. Chemistry, xxvii. (1916) pp. 309–12.

the discussion of the synthetic power of the higher animals, the possible action of the micro-organisms in the intestine must also be considered.

Patterns of Wings in Lepidoptera.*—J. Botke has made an elaborate comparative study. The primitive design of wing-pattern in Lepidoptera is not that of transverse bands (as Eimer believed), nor of spots as in *Zeuzera*, but of transverse inter-nervural tracts. The Cossidæ may be regarded as somewhat primitive. In the genus *Eriocrania* there is at once primitiveness and originality; in *E. sparmanella* the design consists solely of tracts.

In Trichoptera the motifs and main modifications of these are the same as in Lepidoptera. The relation between primary and modified motifs is the same in the two orders. The primitive design in Trichoptera is probably the same as in Lepidoptera.

From the primitive motif may be derived the reticulate scheme, the inter-nervural rows of spots in *Zeuzera*, the arched tracts of Hepialidæ and some other families, and other patterns duly detailed. From the reticulate scheme can be derived the longitudinal figures, denticulate or with approximately straight contours (*Cossus palmaris* and *Endoxyla ligneus*), the transverse bands, and the spots. The "eyes" of *Smerinthus ocellata* are derived from transverse bands.

The primitive Lepidoptera were not white, but had a design borrowed from lower types, such as primitive Panorpidæ. The coloration of nervures is perhaps in part an independent motif and in part the result of an extension or a disappearance of the ornamentation of the "cells." The pigment was primitively carried by the membrane of the wing, afterwards in the scales, the membrane losing it.

Setal Pattern of Caterpillars and Pupæ.†—A. Schierbeek has made a detailed comparative study of the disposition of the setæ in caterpillars and pupæ. He comes to the following conclusions: The organization of the thorax is secondary. The anal segments vary in number in different species. All the abdominal segments had originally a pair of legs. Various types of arrangement can be defined and form a series, one type leading on to another. A metamerically repeated pattern of pigment spots is more primitive than a pattern of stripes. The change of setæ into verrucæ is a reversible process.

From the agreement of the pupal pattern with that of the first instar and its difference from that of the last larval instar, the hypothesis has been developed that the pupa and the first caterpillar instar are both primitive states. The other larval instars are to be considered as secondary adaptations. The pupa is to be considered as a subimaginal stage which secondarily has become non-mobile. The caterpillars of the various families have for the greater part developed independently of or parallel to one another. A general larval pattern for holometabolic insects has not been established with any certainty.

* Onderzoekingen Zool. Lab. Rijksuniversiteit Groningen, No. v. (1916) pp. 1–147 (4 pls.).

† Onderzoekingen Zool. Lab. Rijksuniversiteit Groningen, No. vi. (1916) pp. 1–156 (5 pls.).

Light Reactions of Vanessa antiopa.*—William L. Dolly, jun., has studied the reactions to light in this mourning-cloak butterfly. The facts that the butterfly can orient with but one eye functional, that in a beam of light "circus movements" become less frequent and the angle of deflection decreases with experience, that the degree of deflection is no greater in a light of high intensity than it is in a light of low intensity, that the butterfly can turn under certain conditions toward either side when only one eye is illuminated, and that these insects can in the process of orientation turn either toward the functional or the blinded eye, indicate that orientation in this case is not wholly dependent upon the relative intensity of light on the two eyes. The facts also show that the path in the nervous system along which the impulses travel is not permanently fixed. The nature of the orienting stimulus must be left at present an open question.

Luminescence of Fire-flies.†—E. Newton Harvey has experimented with the American *Photuris pennsylvanica* and *Photinus pyralis*, the Japanese *Luciola vitticollis* and *L. parva*, and the West Indian "Cucullo," *Pyrophorus noctilucans* and *P. havaniensis*, all essentially the same as regards luminescence. A light-producing substance or photogenin is found in the luminous gland-cells; a light-assisting substance or photophelein is distributed throughout the body.

Photophelein is much more stable than photogenin; it may be kept for over seventy days; it dialyses readily through collodion; it is not readily affected by ether and benzol. Photogenin, on the other hand, disappears in less than five hours at 25° C., is quickly destroyed by ether-benzol, and chloroform, and will not dialyse readily, if at all.

Study of a Species of Bracon.‡—James W. Munro has studied a species of an Ichneumon fly, *Bracon*, which is parasitic in the Pine Weevil, *Hylobius abietis*, the most formidable forest-pest in Britain. The female lays eight to twenty-two eggs in the weevil-grub. The eggs are long, spindle-shaped, white, glistening, 0·9 mm. in length by 0·15 mm. in median diameter. They hatch in two to four days. Five larval stages are described. When the parasites are full fed their host is reduced to an empty sac, and the parasites now fill the cavity in the bark previously occupied by their host. It is here they spin their cocoons. The adults are very active and strongly attracted to light.

Bionomics of Lice.§—A. Bacot has made a study of *Pediculus humanus* (*vestimenti*) and *P. capitis*. The former is larger, more robust, less active, with larger and more numerous eggs. Cross-pairing is easily effected, and the offspring are fertile *inter se*; hybrid strains were maintained till the third filial generation, but there remained no reason, judging from breeding results, why such strains should not be continued indefinitely.

* Journ. Exper. Zool., xx. (1916) pp. 357–420 (21 figs.).
† Amer. Journ. Physiology, xlii. (1917) pp. 342–8.
‡ Proc. Roy. Soc. Edinburgh, xxxvi. (1915–16) pp. 313–33 (2 pls.).
§ Parasitology, ix. (1917) pp. 228–58.

The body-louse shows some gregariousness, especially during moulting, and a preference for returning to the same spot for oviposition. These habits are shown, though in a less marked degree, by *P. capitis*. Pairing occurs at any time; the process may last over an hour, but no upper limit was defined. One male of *P. humanus* fertilized eighteen out of twenty-one females placed with him in succession. A male of *P. capitis* fertilized ten females in succession. The longest period during which a female of *P. humanus* retained the power to lay fertile eggs in the absence of a male was twenty days. For *P. capitis* the longest ascertained time was twelve days. For the two species respectively the usual times seem to be sixteen to eighteen and seven to eleven days.

The greatest number of eggs laid by any one female of *P. humanus* was 295, a daily average of 6·4. Five per diem is common. For the other species the figures were 141, with a daily average of four; the general average being 3·7. Fecundity increases with feeding, but the developing power of the eggs laid was not affected by increased feeding.

The longest life observed for a male of *P. humanus* was thirty-two days; for a female, forty-six (with an average of thirty-four). For *P. capitis* the corresponding figures were thirty, thirty-eight, and twenty-seven. The longest lives of unfed lice were at temperatures between 16° and 18° C. Many lived three to four days, two for five days, one for seven days. Active specimens of *P. humanus* survived two days at − 2·3° C. to − 1·1° C., but none recovered after a week's exposure.

Under humid conditions at 31° C., 3 p.c. of 1300 eggs hatched on the seventh day, 56 p.c. on the eighth, 33 p.c. on the ninth, 8 p.c. on the tenth, and 0·2 p.c. later, or on the eleventh. The egg period of *P. humanus* may be estimated at twelve days; a further twelve days is required for the maturity of the female. "Allowing an average of eight eggs per day, spread over a fertility period of forty days, we find that, during her life, a single female may have 4160 offspring."

Copulatory Apparatus of Louse.*—George H. F. Nuttall gives a detailed account of the copulatory apparatus in both sexes of *Pediculus humanus*. Where the subject has been previously approached, it has received scant treatment, and both the structure and the working of the apparatus have been misunderstood. The essential parts of the male apparatus are: (1) the basal plate, (2) the dilator (parameres), (3) the vesica penis, including its rib or strut (statumen penis) embedded in its wall, (4) the penis, and (5) the ductus ejaculatorius. The protrusion and retraction are described. The female apparatus includes a vagina, a vaginal flap, and paired gonopods. The process of copulation is carefully described and figured.

Inheritance of Sex and Pigment in Lice.†—E. Hindle was engaged before the outbreak of war in some experiments with lice. These were interrupted, but a brief account is published of some bearing on the inheritance of sex and melanism. It appears that in *Pediculus humanus*

* Parasitology, ix. (1917) pp. 293–324 (2 pls. and 12 figs.).
† Parasitology, ix. (1917) pp. 259–65.

the broods may be entirely male, entirely female, of both sexes with males predominating, or of both sexes with females predominating. It is difficult to explain the results of the experiments in the case of the third generation where apparently the same crosses produced pure male broods in two cases and a pure female brood in one case. A pure white strain was easily obtained, but great difficulty was experienced in obtaining pure darkly pigmented strains of the darker races. There seems no doubt that the mode of inheritance is alternative.

New Collembola.*—Justus W. Folsom deals with all the known species of North American Poduridæ, with the exception of the subfamily Onychiurinæ. He describes and figures new species of *Achorutes*, *Xenylla*, *Pseudachorutes*, *Odontella*, *Paranura* and *Neanura*.

γ. Prototracheata.

New Species of Peripatus.†—E. L. Bouvier describes *Ooperipatus paradoxus* sp. n., from Queensland. The most striking features are the development of a pair of papillæ at the base of the foot (as in the African *Peripatopsis*), and the presence of a genital tube in both sexes. This tube resembles in the male that of *Paraperipatus*, and in the female that of *Ooperipatus*. The author also discusses *Peripatoides woodwardi* Bouvier and *Ooperipatus oviparus* Dendy.

δ. Arachnida.

British Pseudoscorpions.‡—H. Wallis Kew gives an interesting historical account of the books and papers, from Hooke's "Micrographia" (1665) onwards, which have made additions to the list of British pseudoscorpions. Forty references are given, and the number of species is twenty-four.

Traces of Tracheæ in Sarcoptids.§—E. Trouessart describes a stigmatic orifice in *Hyperalges magnificus*, a plumicolous Sarcoptid. The position of the stigma and its peritrema is on a flexible area of the cuticle which separates the base of the first limb from the rostrum and the epistoma. He has found a similar stigmatic peritrema in Analgesidæ, Proctophyllodeæ, Pterolichidæ. These vestiges of a tracheal system show that the division of Acarines into Tracheata and Atracheata is not very satisfactory.

ε. Crustacea.

Crustaceans from High Altitudes.‖—Charles Chilton reports on two Isopods and two Amphipods from Barrington Tops (4000 feet),

* Proc. U.S. Nat. Museum, l. (1916) pp. 477–525 (19 pls.).
† Arkiv f. Zool. x. (1916) pp. 1–22 (1 pl.).
‡ Journ. Quekett Micr. Club, xiii. (1916) pp. 117–36 (2 figs.).
§ Bull. Soc. Zool. France, xli. (1917) pp. 61–4 (2 figs.).
‖ Proc. Roy. Soc. N.S. Wales, 1916, pp. 82–97 (22 figs.).

near Dungog, New South Wales. Two of the species are new, the Isopod *Cubaris helmsianus* and the Amphipod *Gammarus barringtonensis*, the former terrestrial, the latter from fresh water. The other forms are the fresh-water Isopod *Phreatoicus shephardi* Sayce, and the terrestrial Amphipod *Talitrus sylvaticus* Haswell. All four forms present points of individual interest, and their geographical distribution is important.

Immersion Experiments on Ligia oceanica.*—John Tait calls attention to the terrestrial mode of life which is now habitual with this species. Specimens placed in half sea-water survived from sixteen to forty-two days. Only in one case (that of thirty-seven days' survival) was there any appreciable change at death; this consisted in the swelling of one internal gill-lamella. In quarter sea-water there was survival for three to fifteen days. Two of the animals showed marked œdema before death. One of these, replaced in sea-water, recovered its power of movement, and on the following day the œdema had subsided. Over one hundred and fifty experiments were made with distilled water. After the first eight or nine hours individual animals began to die, and this might continue for at least thirty-six hours thereafter. Œdema is common, but not invariable. There is an extraction of salts from the body. The longest survival-period accurately measured was forty-four to forty-five hours. The resistance in recently moulted specimens is greater than with specimens that had moulted some time before. The animals can live for three months in sea-water in apparent comfort, yet they prefer a land habitation. There may be respiratory reasons for this.

Moulting in Ligia.†—John Tait finds that *Ligia*, like other Isopods, moults in two stages. First the covering of the abdomen with that of the posterior three thoracic segments is exuviated. About four days later the covering of the anterior region of the body is thrown off. The author describes the external changes in the cuticle as it ages, and the behaviour of the animal during the process of moulting.

At the moult the cuticle splits in two main directions: (1) transverse, between the fourth and fifth (free) thoracic segments; (2) longitudinal, at the coxotergal junctions of (free) thoracic segments 2 to 7, there being no coxotergal split in segment 1. Coxotergal splitting is an arthrostracan, if not a peracaridan, feature.

Specimens that have fasted for many weeks in sea-water may still moult normally. It follows that onset of the moult is determined by an underlying cyclic change, not, as Réaumur suggested, by simple growth of the animal. A second moult during the period of fast was not observed.

Limb-flexures and Limb-taxis on Peracarida.‡—John Tait has studied in a very interesting way the question of limb-flexion as met with in Peracarid Crustaceans. He is led on to a discussion of the

* Proc. Roy. Soc. Edinburgh, xxxvii. (1917) pp. 50–8.
† Proc. Roy. Soc. Edinburgh, xxxvii. (1917) pp. 59–68.
‡ Proc. Roy. Soc. Edinburgh, xxxvii. (1917) pp. 69–94.

distinction between homology and analogy, and of the relations between form and function. His precise object was to obtain light on what he calls "the functional heredity" of the limbs of *Ligia*.

Each walking-leg of the common littoral Isopod *Ligia* shows three prominent flexures arranged alternately in one plane. Generally speaking, the planes of flexure of the whole series of seven limbs are transverse to the body, the basipodites flexing medially. This Isopodan limb-taxis is associated with clinging power.

In Amphipoda and in Tanaidacea there are likewise three chief flexures in the limb, which are also arranged tri-alternately and in one plane. In the Tanaidacea the basipodites project laterally, not medially. In the Amphipoda the basipodites flex antero-posteriorly. Tanaidacean limb-taxis seems to be the primitive mode.

The tri-alternate flexion-complex in each limb of these Peracarids, as well as in certain limbs of Cumacea, is a reptant feature; so is the separation of the seven limbs into two opposing groups. The author suggests an analogy with the limbs of reptant vertebrates. By simple inspection it is usually possible to say if a crustacean limb used for swimming has been secondarily modified from a reptant limb.

The flexion-complex in the limbs of reptant Eucarida is neither tri-alternate nor uniplanar, as in the limbs of reptant Peracarida. This distinction is of more importance than that suggested by Boas, which relies upon the amount of flexion possible at the mero-carpal and at the carpo-propodal articulation respectively.

The Peracarida, like the Decapod Crustaceans, may be divided into natant and reptant forms, with intermediate links. Of the reptant forms only those with Isopodan or Amphipodan limb-taxis have shown themselves capable of adopting a terrestrial life. The different forms of limb-taxis in the Peracarida and certain features involving the flexion-complex present problems "analogous" to the rotation and torsion that occur in the fore-limb of a developing mammal. This suggests, indeed, the main interest of this remarkable paper, which we cannot do justice to in summary: the endeavour to re-unite the endeavours of morphological and physiological analysis.

Antarctic Ostracods.*—Frederick Chapman reports on Ostracods collected on Sir Ernest Shackleton's Antarctic Expedition, from elevated deposits on the shores of the Ross Sea, and from marine muds from soundings in the Ross Sea. Five species of Ostracods were obtained from upthrust muds above the Drygalski Glacier, south-east of Mount Larsen. One of them is new—*Cytheropteron antarcticum* sp. n.—the others are southern oceanic forms. From elevated deposits on the slopes of Mount Erebus eight species were obtained, including two new species, *Loxoconcha mawsoni* and *Xestoleberis davidiana*. The Ostracods from the muds (eleven species, including *Cythere davisi* sp. n.) represent in the main a southern oceanic fauna. A marked exception is *Cytherura rudis*, previously known from Spitzbergen, Greenland, and the Far North.

* Reports Sci. Invest. Brit. Antarc. Exped., Geology, ii. (1917) pp. 37–40 (1 pl.); pp. 49–52 (1 pl.); pp. 71–5 (1 pl.).

X 2

Commensal Ostracod.*—P. Paris describes *Sphæromicola topsenti* g. et sp. n., a remarkable commensal Ostracod found attached to cavernicolous Isopods—namely, *Cæcosphæroma virei* Dollfus from the Jura, and *C. burgundum* Dollfus from Burgundy. The creature lives on the under surface of the Isopod at the base of the appendages, especially of those in front. There are usually several living together. The relatively large white ova (125 μ in longest diameter) are fixed singly by cement to the Isopod and do not exceed three or four in number. The animal has a shining surface and a pure white colour, transparent in the appendages. There is no trace of eyes. The external genital organs are strongly developed. The female was about 415 μ in length, the male about 440 μ.

Luminescence of Japanese Species of Cypridina.†—E. Newton Harvey has studied the Japanese Ostracod *Cypridina hilgendorfi* Müller in relation to its luminescence. The luminous secretion comes from several spindle-shaped yellow cells on the upper lip, and is exuded into the sea as perfectly clear granule-free non-fluorescent material. The light is homogeneous and bluish-white in colour. If the luminous secretion stands, the light disappears; if there be added an extract of *Cypridina* heated to boiling, the light returns. Thus this Ostracod gives a luciferin-luciferase reaction similar to that given by *Pholas dactylus* as described by Dubois. Contrary to Dubois, the author finds that the luciferase is the source of the light, and not an enzyme causing light-production by oxidation of luciferin, for light can be obtained from luciferase by substances incapable of oxidation, such as salt, chloroform, and ether. The new names of photogenin or light-producer for luciferase, and photophelein or light-assistor for luciferin are proposed.

Oxygen is necessary for light-production. Both photogenin and photophelein will easily pass through a Pasteur-Chamberlain or Berkefeld filter. Photophelein dialyses readily through heavy parchment or collodion, photogenin with great difficulty or not at all. The light-producing substances may be dried and thoroughly extracted with ether without impairing their light-giving power. Photophelein occurs throughout the body of *Cypridina*, photogenin only in the luminous organ. While photogenin will give light with many substances, photophelein will give light only with the photogenin of the luminous organs. Many other facts are demonstrated. In the natural secretion of *Cypridina*, or in the whole animal, there is always enough photogenin to completely use up the photophelein. The photogenin from one animal will use up a large additional amount (at least 100 times the concentration in one animal) of photophelein, but not an indefinite amount, so that photogenin is not a true enzyme in the strict sense of the word, unless it be an enzyme poisoned by its own reaction products. The photogenin-photophelein system resembles the zymase-co-zymase system to a remarkable degree, but it is best for the present to regard photogenin not as an enzyme, but merely as a substance auto-oxidisable only in presence of photophelein.

* Comptes Rendus, clxiii. (1916) pp. 307–9.
† Amer. Journ. Physiol., xlii. (1917) pp. 318–41.

Annulata.

Nervous System of Owenia and Myriochele.*—W. C. M'Intosh gives an account of the minute structure of the nervous system as seen in sections. The main feature is the partial differentiation of the nerve-tissue from the hypoderm with which it is in continuity at its centre. No sheath is evident anywhere, even in the most distinctly outlined nerve-cords posteriorly. Yet the position of the cephalic centre and its connexion by two trunks with the ventral nerve-cord agree with the general type. The innervation of the alimentary canal seems to be carried out on a similar plan to that of the main system, viz. by contact with a sensitive layer rather than by special twigs. The whole nervous system, in fact, is in a somewhat elementary or larval condition.

Calliobdella nodulifera Malm.†—W. Harold Leigh-Sharpe describes this marine leech from the saithe (*Gadus carbonarius*) and compares it with other species. The epidermis consists of a layer of columnar cells elongated in a direction at right angles to the long axis of the body, having their nuclei, which are large, away from the external border where a cuticle is secreted. At frequent intervals among the epithelial cells are flask-shaped glandular cells making mucus. The dermis is rich in large flattened cells with large flattened nuclei, embedded in a connective tissue matrix with numerous fibre-forming cells. The dermis also includes large pigment cells. Below the dermis lie the muscle layers, and below these the cocoon-gland cells. The body cavity is represented by dorsal, ventral, lateral, and intestinal sinuses. The ventral blood-vessel is outside the ventral sinus, one of the characters distinguishing *C. nodulifera* from *C. lophii.*

Nematohelminthes.

Development of Ascaris.‡—F. H. Stewart has studied the development of *Ascaris lumbricoides* and *A. suilla* in the rat and mouse. The eggs hatch in the gut; a certain number of the larvæ escape in the fæces; they can survive for at least three days, but probably succumb ultimately; the majority enter the body. The time elapsing between infection and the entrance of the larvæ into the body is probably not more than two days. Larvæ are found in lungs, liver, and other parts. The diameter of a larva is three times that of a red blood corpuscle of the mouse, so the larvæ cannot pass through the lumen of an ordinary capillary vessel. There must be some boring. The possible routes by mesenteric venules and bile-ducts are discussed. During their residence in mouse or rat the larvæ grow from a length of 0·22 mm. to 1·4 mm.

* Ann. Mag. Nat. Hist., xix. (1917) pp. 233–65 (6 pls.).
† Proc. Roy. Phys. Soc. Edinburgh, xx. (1917) pp. 118–22 (2 pls. and 1 fig.).
‡ Parasitology, ix. (1917) pp. 213–27 (1 pl. and 9 figs.).

Sclerostome Parasites of the Horse in England.*—Charles L. Boulenger continues his very useful account of the Nematodes of the horse. He has found no fewer than eight species of *Cylichnostomum* in the Midlands, and gives a careful description of three of them that are new—*C. euproctus*, *C. insigne*, and *C. goldi.*

Worm Nodules in Cattle.†—W. Nicoll communicates some observations on the baffling life-history of worm nodules in cattle. He made a thorough examination of ten calves, from five to eleven months, bred and reared on a common, a wide stretch of variegated land, on which approximately seven hundred to eight hundred head of cattle were grazing. These cattle were removed from time to time and replaced by others, and a large proportion were constantly infected with nodules. The experiment was carried on for six months of abnormally dry weather. No calf showed any trace of *Onchocerca* larvæ in the blood or in any part of the body, either free or encapsuled.

Nematodes from Rodentia, Lagmorpha, and Hydracoidea.‡—Maurice C. Hall gives a valuable account of a large number of Nematodes from the orders of mammals named. Many new forms are described. Five superfamilies are recognized :—Angiostomoidea, Trichinelloidea, Strongyloidea, Ascaroidea, and Filaroidea. Numerous illustrations are given of the minute structure of the cuticle, of the two extremities, of the male bursa, and of the eggs.

Influence of Salt on Development of Hook-worms.§—W. Nicoll has studied the influence of salt and other agents in modifying the larval development of *Ankylostoma duodenale* and *Necator americanus.* Ankylostomiasis has obtained a very firm hold in the coastal districts of North Queensland, and is very difficult to cope with. The promiscuous distribution of excreta is the chief source of the spread of the infection. Common table-salt has a decidedly injurious effect on the hook-worm eggs if brought into intimate contact with the infected fæcal material. A mixture of sand promotes the development of the larvæ ; when used as a covering of a certain depth it arrests development. Exposure to direct sunlight of sufficient intensity kills hook-worm eggs and larvæ very rapidly.

Incertæ Sedis.

New Record of Enteropneust on French Coast.‖—M. Caullery and F. Mesnil report the occurrence of what seems to be *Dolichoglossus kovalevskii* Ag. near Cape Hague on the French coast. Five other species of Enteropneust have been recorded from French coasts. The previously known habitat of *D. kovalevskii* was on the Atlantic coast of the United States.

* Parasitology, ix. (1917) pp. 203–12 (5 figs.).
† Reprint from Med. Journ. Australia, Dec. 4, 1915, pp. 1–8.
‡ Proc. U.S. Nat. Museum, l. (1916) pp. 1–258 (1 pl. and 290 figs.).
§ Parasitology, ix. (1917) pp. 155-89.
‖ Bull. Soc. Zool. France, xli. (1917) pp. 125–7.

Rotatoria.

Bdelloid Rotifers of South Africa.*—W. Milne continues his account of these, describing three more new species of *Macrotrachela*, nine of *Habrotrocha*, the new genus *Otostephanos* with two new species, and new species of *Pleuretra*, *Scepanotrocha*, *Mniobia*, and *Adineta*. The new genus *Otostephanos* has a ring of fair thickness round the corona, with short breaks dorsally and ventrally. Whether this ring is real, as Milne believes, or a ghost, as Bryce believes, its appearance is distinctive. The name *Monoceros*, used in a previous paper, is pre-occupied, and is replaced by *Henoceros*.

Echinoderma.

Division of Sea-urchin Ova.†—Ralph S. Lillie has studied the influence of hypotonic sea-water on the divisions of the egg of *Arbacia*. Sea-water of a dilution sufficient to cytolyse all unfertilized eggs in half an hour or less, causes osmotic swelling, but not cytolysis, in undivided fertilized eggs (up to a few minutes before cleavage begins). At or about the time of formation of the cleavage-furrow a marked decline takes place in the resistance of the egg to hypotony, and cytolysis is then rapid and complete. When the cleavage-furrow is fully formed the original resistance returns. A similar reversible decline of resistance takes place at the second and third cleavage, and is probably general for mitotic cell-division.

The minimum of resistance is found during the formation of the furrow. Both the decline and the return of the resistance are rapid, the greater part of each phase occupying four to five minutes at 22° C. Some increase of susceptibility is apparent ten or twelve minutes before the first appearance of the furrow.

A decrease in the coherence or extensibility of the plasma membrane at the time of cytoplasmic division is thus indicated. The earlier observations of Lyon and other investigators have shown that an increase of susceptibility to poisons, heat, and other injurious conditions, together with an increased output of CO_2, takes place at this time, i.e. simultaneously with this change in the membrane. The above facts constitute additional evidence that an intimate connexion exists between the general physiological condition of the egg and the physical state of the plasma-membrane.

The above change in the membrane is probably associated with an increased permeability to water-soluble substances and a decreased electrical polarization; this latter change, according to the law of electrocapillarity, involves increased surface-tension. From the analogy with the general stimulation-process, it seems also probable that the change of polarization acts upon the conditions within the dividing cell (oxidations, etc.) in a manner analogous to the similar change in electrical stimulation in general.

* Journ. Quekett Micr. Club. xiii. (1916) pp. 149–84 (5 pls.).
† Journ. Exper. Zool., xxi. (1916) pp. 369–402.

The following hypothesis of cytoplasmic division is put forward. The change of form is the result of two chief factors: (1) a definitely localized increase of surface-tension, resulting directly from the increased permeability and decreased electrical polarization of the cell-surface, over two symmetrical areas centring at the poles and extending to near the equator; and (2) a secondary or adjuvant effect of the same kind due to the diffusion of electrolytes (e.g. acid derived from oxidations) from the astral centres or centrioles, which become chemically active at this time. These centres appear to represent aggregations of a special colloidal material which undergoes oxidation when the cell-surface undergoes depolarization.

Cœlentera.

Luminescence of Cavernularia.* —E. Newton Parker has experimented with the common Japanese Pennatulid, *Cavernularia haberi*, which, if stimulated by touch, or electrically, or by the addition of ammonia, gives off from its whole surface a brilliantly luminous slime. The slime is produced by gland-cells, and contains minute luminous granules. A considerable amount of oxygen is used up in light-production, and there is no light without oxygen. The production of light by the granules is comparable to the cytolysis of cells, as it occurs with water (but not isotonic cane-sugar) and certain cytolytic substances (saponin, chloroform, benzol, and oleic acid).

Nervous Transmission in Actinians.†—G. H. Parker has experimented with *Metridium*, and finds that nervous transmission may be accomplished from almost any part of the ectoderm to its longitudinal mesenteric muscles. Experiments in which the receptive part of the anemone is connected with the effector portion by only a small bridge of tissue, demonstrate that these nervous connexions occur in such a variety of positions as to call for the assumption of a nerve net. These connexions in many places pass directly from the ectoderm, through the mesoglœa, to the endoderm. In connecting the ectodermic with the endodermic systems, the lips and probably the œsophagus are not as important as many other parts of the body.

Notwithstanding the generally diffuse condition of the transmission system in *Metridium*, there is evidence also for a certain degree of specialization in this system. Stimulation of the tentacles by mussel-juice calls forth a gaping of the œsophagus (contraction of the transverse mesenteric muscles). Stimulation by weak hydrochloric acid calls forth a retraction of the oral disk (contraction of the longitudinal mesenteric muscles). These two forms of response afford good ground not only for the assumption of independent receptors, but for the belief in relatively independent transmission tracts, a first step in the kind of differentiation so characteristic of the nervous organization in the higher animals.

* Amer. Journ. Physiol., xlii. (1917) pp. 349–58.
† Journ. Exper. Zool., xxii. (1917) pp. 87–94 (3 figs.).

Movements of Tentacles in Actinians.*—G. H. Parker has studied the well-known power that the tentacles of sea-anemones have of carrying out many of their normal activities even after they have been cut from the body of the polyp. This peculiarity has been accepted as evidence that each tentacle contains a neuro-muscular arrangement sufficient for its own activity, and that it is therefore not dependent upon the nervous control of other parts of the animal's body for the production of those movements that it ordinarily exhibits. To test the validity of this view experiments were made on *Metridium marginatum*, *Sagartia luciæ*, and *Condylactis passiflora*, the last being most suitable because of the large size of its tentacles.

A severed tentacle of *Condylactis*, suspended in sea-water by a small metal hook, may be inflated by running water into it until it has attained about two-thirds of its natural length. It then has a fluid-pressure very nearly that which was natural to it, and not greater than a few millimetres of water. If this be much increased the tentacle contracts vigorously and discharges much of the contained water. The slightly contracted state of the expanded, excised tentacle is not due to lack of pressure, nor to the absence of inhibitory influences from the rest of the polyp, but to the cut at its base, which increases the tonicity of its neuro-muscular arrangements.

Excised tentacles stimulated by mechanical means, by food, or by chemicals, react in essentially the same way as attached tentacles do, though the reactions are feebler and less precise. Stimuli applied to the ectoderm of a tentacle are followed quickly by a muscular response ; applied to the endoderm they are followed slowly by the same form of response. This means that the endodermic surface is not receptive, and that stimulating substances applied to it make their way only slowly to the ectoderm. If there is a nervous layer in the endoderm of the tentacles of *Condylactis* it must be extremely simple in structure and function, as compared with that in the ectoderm.

The tentacles of *Condylactis* through their reactions exhibit marked polarity, both ciliary and neuro-muscular. The latter disappears on narcotization with chloretone. It is probably dependent on the direction taken by the nerve-fibrils which emerge from the sense-cells. Where this direction has been determined it is predominantly towards the proximal end of the tentacle.

The general conclusion is that "the Actinian tentacle, in contradistinction to such appendages as those of the Arthropods or the Vertebrates, contains a complete neuro-muscular mechanism by which its responses can be carried out quite independently of the rest of the polyp."

Pedal Locomotion in Actinians.†—G. H. Parker finds that the direction of creeping in Actinians is independent of their secondary axis. In a single specimen of *Actinia* or *Sagartia* the direction may change from time to time without relation to the secondary axis. The bilaterality of Actinians, therefore, is not locomotor as in most animals.

* Journ. Exper. Zool., xxi. (1917) pp. 95–110 (1 fig.).
† Journ. Exper. Zool., xxi. (1917) pp. 111–24 (1 fig.).

It is probably respiratory. The locomotion is accomplished by a wave-like movement which progresses over the pedal disk in the direction of locomotion. Each point on the disk is successively raised from the substratum, moved forward, and put down. The attachment of *Condylactis*, *Sagartia*, and other forms studied, is due chiefly to adhesion heightened by the secretion of a thick slime rather than to a sucker-like action of the pedal disk.

The locomotion is due to the circular muscle of the pedal disk, the basilar muscles, and the longitudinal muscles of the mesenteries, all of which act on the fluid-filled spaces in the pedal region of the animal. The pressure thus generated is not above that of 6 c.cm. of water. Creeping can be effected by an Actinian from which the oral disk has been cut away. It follows that the pedal portion of the anemone, like its tentacles, must have a neuro-muscular equipment sufficient for its own activity.

In a specimen of *Sagartia* with a pedal disk about 4 mm. in diameter the locomotor wave coursed over the disk in an average time of 1·65 minutes. With each wave the animal progressed on the average 1·2 mm. In a specimen of *Condylactis* with a pedal disk 130 by 80 mm., the passage of a locomotor wave required on the average three minutes, and the animal progressed for each wave on the average 11·4 mm.

Heliotropism in Eudendrium.* — Jacques Loeb and Hardolph Wasteneys have re-investigated the behaviour of the hydroid *Eudendrium*, which is positively heliotropic, to test afresh how it conforms to the Bunsen-Roscoe law whereby the heliotropic effect is determined by the product of the intensity into the duration of illumination. Experiments carried on by a somewhat different method from those previously published by Loeb and Ewald harmonize with the idea that the Bunsen-Roscoe law is the correct expression of the influence of light on the heliotropic reactions of the hydroid.

Porifera.

Animals Associated with a Sponge.† — Ch. J. Gravier describes an interesting association. A Hexactinellid sponge described by Topsent as *Sarostegia oculata*, with many branches spreading in a fan-like fashion, was found to be covered by small Actinians, the largest 4 mm. in diameter. The Actinians have two circles of endacmian tentacles, about thirty in number; the mesenteries have weak musculature; there are no acontia or cinclidæ; the outer surface is rigid with a coating of Foraminifera. On dead branches there were no Actinians. It seems therefore that they utilize the currents produced by the sponge. Inside the sponge in branching galleries there lives a species of *Hermadion* in the polychæt family Polynoidæ, which may perhaps secure the absence of more objectionable creatures.

* Journ. Exper. Zool., xxi. (1917) pp. 187–92.
† Comptes Rendus, clxiv. (1917) pp. 333–6.

Axinellid Sponges.*—E. F. Hallman has made a revision of the genera with microscleres which have been included in the family Axinellidæ. He also describes a number of new Australian forms. Much attention is given to the spicules.

Sponges of Lake Biwa.†—Nelson Annandale and Tamiji Kawamura deal with a collection of Spongillidæ from Lake Biwa, Japan. Seven species are distinguished, of which *Hetermeyenia kawamuræ* Annandale is new. The only fresh-water sponge previously found in Japan is the typical form of *Ephydatia mülleri* (Liebk.), of which a new variety is now described. The majority of the species are widely distributed Holarctic forms, but *Spongilla clementis* is probably of Oriental origin. The distribution of species in the lake is correlated with definite environmental differences. Several forms, especially *S. clementis*, differ considerably in different surroundings. The sponges in Lake Biwa attain their full growth as a rule somewhat later in season than those of Europe. No form is known that produces gemmules at the beginning of the hot weather. On the surface and in the canals of *S. clementis* there are various incolæ (e.g. a Heteropteron and a Gammarid) of various groups. The sponges often overwhelm the shells of Gastropods and Lamellibranchs, becoming a sort of parasite.

Japanese Calcareous Sponges.‡—Sanji Hozawa describes seven species in the family Heteropiidæ, six of which seem to be new. There are four new species of *Grantessa*, besides *Heteropia striata* sp. n. and *Amphiute ijimai* sp. n. An account is given of the canal system, skeleton, and individual spicules in each case.

Protozoa.

Reaction of Amœbæ to Food.§—A. A. Schaeffer finds that amœbæ eat isolated proteins supplied to them. Globulin (crystallin) was eaten quite readily, and particles of it underwent reduction in size in the cytoplasm; lactalbumin was sometimes eaten, ovalbumin only occasionally. Zein attracts, but is not ingested. Keratin and fibrin were eaten occasionally; aleuronat and grain gluten frequently.

Isolated proteins are sometimes ingested in food-cups of varying size, sometimes without the formation of food-cups. In the latter case the cytoplasm simply flows around the food particle. Occasionally a food-cup is started before the amœbæ comes into contact with the protein particle. Granular amœbæ ate isolated proteins much more readily than did "raptorial" amœbæ, and they retained more readily what they ate.

It cannot be stated what qualities in these proteins induce ingestion. The fact that the one which is probably the most readily purified, namely,

* Proc. Linn. Soc. N.S. Wales, xli. (1916) pp. 453–91 (9 pls. and 9 figs.), and pp. 495–552 (10 pls. and 7 figs.).

† Journ. Coll. Sci. Univ. Tokyo, xxxix. (1916) Art. 1, pp. 1–27 (2 pls.).

‡ Journ. Coll. Sci. Univ. Tokyo, xxxviii. (1916) pp. 1–41 (2 pls. and 7 figs.).

§ Journ. Exper. Zool., xxi. (1917) pp. 53–86 (6 pls.).

zein, is not eaten, suggests that minute traces of soluble material may be present in globulin, lactalbumin, and ovalbumin. It is also possible that these proteins are very slightly soluble in the water in which amœbæ live.

Some facts in regard to general behaviour are noted. An amœba utilizes the vestige of a former pseudopod for the projection of a new one whenever it is possible, rather than form an entirely new one. "The reactions of an amœba at a given time are, in a definite manner and to a large extent, conditioned by its behaviour, that is, by changes in the shape of its body, during the preceding minutes."

"There is a large amount of objective evidence that positive and negative tendencies of reaction with respect to a single source of stimulation are effectively present in amœba, and that reactions are not due in any sense to the direct effect of the stimulus."

Amœbæ of Human Intestine.*—N. H. Swellengrebel and R. M. M. Winoto have found, besides an ordinary "limax" amœba, another form of the same type which has different cysts and different physiological characters. It is considered to be a true intestinal parasite, but its pathogenic character is doubtful. Its structural features separate it from other intestinal parasites—from *Entamœba coli* and *E. histolytica*, where the motile forms and cysts are larger; from the four-nucleate cysts of *Chilomastix mesnili*, which, though of the same size, show a different nuclear structure (vesicular); from *Blastocystis hominis*, which has a characteristic refractile appearance.

Antarctic Foraminifera.†—Frederick Chapman reports on Foraminifera collected on Sir Ernest Shackleton's Antarctic Expedition, from elevated deposits on the shores of the Ross Sea. From upthrust muds above the Drygalski glacier, south-east of Mount Larsen, twenty-four species were obtained, twelve of which have been already noted from the sub-Antarctic islands of New Zealand. There is a considerable proportion of deep-water forms. The bipolar theory is supported by the occurrence of *Biloculina sarsi*, which forms a large proportion of the "*Biloculina* clay" of the North Sea. The author also reports on Foraminifera from elevated deposits on the slopes of Mount Erebus, near Cape Royds. Twelve of the twenty-two species are common to the deposit south-east of Mount Larsen.

Foraminifera from Ross Sea.‡—Frederick Chapman reports on a collection made on Sir Ernest Shackleton's Expedition, from muds from soundings in the Ross Sea. There were sixty-four species and varieties, including *Reophax longiscatiformis* sp. n., *R. murrayana* sp. n., and three new varieties. A notable feature is the large number of species which are undoubtedly common to the cold areas of the North and

* Parasitology, ix. (1917) pp. 266–73 (1 pl. and 1 fig.).
† Reports Sci. Invest. Brit. Antarc. Exped., 1907–9, Geology, ii. (1917) pp. 27–34 (3 pls.); pp. 41–6 (1 pl.).
‡ Reports Sci. Invest. Brit. Antarc. Exped., 1907–9, Geology, ii. (1917) pp. 55–79 (5 pls.).

South Polar regions. Of these "bipolar" species the most interesting is perhaps *Saccamina sphærica*, since it has been almost exclusively obtained from stations in high latitudes, and only twice in low latitudes, in the North Pacific and South Atlantic, both in deep water—in the main axes of abyssal troughs trending north and south. "In this, as in other species of bipolar Foraminifera, the following fact is clearly brought out: that these tiny organisms, born and bred in the richer, shallow mud-zones of higher latitudes, sink into deeper water areas when spreading out through the tropical and inter-tropical seas, and again graduate into shallower marine conditions as they approach the polar regions. The shallow-water foraminiferal faunas of warmer latitudes, on the other hand, show, broadly speaking, a restricted field." It is noted that *Reophax spiculifera*, living side by side with *R. dentaliniformis*, which makes a test of comparatively coarse angular sand grains, "rejects this material in favour of short, siliceous sponge spicules, with which awkward material it constructs fairly neat, long, funnel-shaped chambers, resembling in shape the straw covers of wine-bottles."

Rejuvenescence in Protozoa.*—Lorande Loss Woodruff summarizes his work on rejuvenescence in *Paramœcium* and other Infusorians. A race of *P. aurelia* after more than eight years (1915) in culture is still in a normal condition, having attained over 5250 generations without conjugation or the use of artificial stimuli. The continued vitality depends on the composition of the medium more than on changes in it. There are periodic rises and falls in the division-rate, from which recovery is self-regulated. The members of the long-lived race are able to conjugate when the proper conditions for conjugation are realized. The very limited periods in which Maupas, Calkins, and others observed degeneration of *Paramœcium* have no significance for the question as to whether degeneration and death are inevitable consequences of reproduction without conjugation. The positive fact is clear that the organisms can live on indefinitely, when subjected to favourable environmental conditions, without conjugation or artificial stimulation.

Woodruff and Erdmann found that the rhythms are the physiological expression of internal phenomena which involve the formation of a complete new nuclear apparatus, by a definite sequence of normal morphological changes that simulate conjugation. This nuclear reorganization (endomixis) consists, in essence, of the gradual disintegration and absorption of the macronucleus in the cytoplasm. Simultaneously, a multiplication of the micronuclei is in progress. Certain of the resulting micronuclei degenerate, the remaining one (or two) forming the new macronuclear and micronuclear apparatus. There is an absence of the third micronuclear division, which, in conjugation, forms the stationary and migratory micronuclei. Obviously there is no syncaryon. The process is not a result of culture, nor peculiar to one culture. The endomixis might be considered as an automatic antidote to senescence, but so, perhaps, might anabolic ascendancy after a katabolic phase. A demonstration of the fact that conjugation may be dispensed with does not prove that conjugation has no dynamic function. The author

* Biochemical Bull., iv. (1915) pp. 371–8.

inclines to believe that it has. Both conjugation and endomixis secure re-arrangement of the molecular constitution of the cell—conjugation by amphimixis, endomixis by internal re-organization. Both may be rejuvenating and be followed by an acceleration of vital processes.

Flagellate Infections of Intestines and Liver.*—P. B. Hadley publishes an account of an experimental study of the rôle of the flagellate Protozoa in infective processes of the intestines and liver. The *Trichomonas* studied is a flagellate Protozoon found in the intestines of all poultry, as well as of other animals. It is pear-shaped, elongate, half-moon-shaped or globular according to the stage of development. It manifests the usual *Trichomonas* characteristics. The flagellates are present in the cœcal contents, but are found mainly in the mucous layer overlying the epithelium and often deep in the crypts of Lieberkühn. The morphology, encystation, and conjugation of the parasite are described, and the pathological cœcal symptoms, macroscopical and microscopical, are indicated. The author concludes that intestinal flagellatosis cannot be regarded as an infectious disease, and *Trichomonas* as found in these cases ("blackhead" in turkeys) is not a pure, but only a facultative parasite. A successful infection depends upon factors present in the host, and is probably quite unrelated to virulence on the part of the infecting organism.

A second paper † by the same author describes the avenue and development of tissue-infection in intestinal trichomoniasis, and gives evidence of the identity of certain stages in the development of *Trichomonas* with *Amœba meleagridis*, first reported by Theobald Smith, and maintained by him to be the cause of the disease. The writer concludes that the presence of large numbers of flagellates in the cœcal canal is not the cause but the result of the accompanying and preceding diarrhœa.

Structure and Division of Nyctotherus ovalis.‡—Antonio de Zuluetta has studied this Heterotrichous commensal in the intestine of the cockroach (*Blatta orientalis*). The endoplasm is divided by a diaphragm which is in contact centrally with the anterior surface of the nucleus and is united peripherally with the cortical layer. The endoplasm of the anterior region has a more distinct, alveolar structure than the posterior region, and is also more limpid. During division the diaphragm disappears, the endoplasm becomes uniform. When the daughter-individuals have attained a certain size the endoplasm re-differentiates in each into two regions, and a new diaphragm is formed. The diaphragm appears as a lamella of variable thickness, striated or sub-fibrous radially. It is probably comparable to the partition between the protomerite and deutomerite in Polycystid Gregarinids. The figures given are very interesting.

* Agric. Exper. Stat. Rhode Island College, Bull. 166 (1916) pp. 1–40 (3 pls.).

† Agric. Exper. Stat. Rhode Island College, Bull. 168 (1916) pp. 1–64 (11 pls. and 2 figs.)

‡ Trabajos Mus. Nacional Ciencias Naturales, Madrid, serie Zoologica, No. 26 (1916) pp. 1–16 (6 figs.).

Myxosporidia at Roscoff.*—Jivoïn Georgévitch reports on a number of Myxosporidia which he collected from fishes at Roscoff. Out of 287 fishes examined 171 had Myxosporidia. Most of these were species of *Myxidium* which occurred in the gall-bladder, and species of *Sphæromyxa* and *Chloromyxum*. The infection is usually simple, in fact only one instance, in *Syngnathus acus*, was found of a double infection. All the species sporulate in the interior of plasmodia, which are sometimes so large that they completely fill the gall-bladder. The spores are set free by the liquefaction of the plasmodium; sometimes the interior of the plasmodium becomes fluid before the sporulation is completed. In *Sphæromyxa balbianii* in *Motella tricirrata* the division of a plasmodium into two was observed. A description is given of *Myxidium gadi* sp. n., *Sphæromyxa gasterostei* sp. n., and three other species.

Orientation of Gonium.†—A. R. Moore calls attention to Mast's investigation ‡ of the orientation of this Flagellate. Mast accounts for the orientation to a directive stimulus (light), by supposing the zooids farthest from the source of light to increase their activity, and thus bring the plane of the colony perpendicular to the lines of the stimulating force. He assumes equal activity of the two flagella in each cell of the colony, the behaviour of the cells varying only in the intensity of their activity. He does not consider the possibility which Moore and Goodspeed previously § pointed out, viz. that the turning may be accomplished by an inequality in the beating of the two flagella of each cell. This mode of orientation has been observed by Bancroft in *Volvox*, by Ludloff in *Paramœcium*. There may be a cessation of beat or a reversal of stroke of the flagellum on the stimulated cell. It may be that there is also, as Mast concludes, an increased activity of the cells away from the side stimulated.

* Bull. Soc. Zool. France, xli. (1917) pp. 86–95 (23 figs.).
† Journ. Exper. Zool., xxi. (1916) pp. 431–2 (2 figs.).
‡ Journ. Exper. Zool., xx. (1916) p. 1.
§ Univ. California Publications, Physiology, iv. (1911) p. 17.

BOTANY.

GENERAL,

Including the Anatomy and Physiology of Seed Plants.

Structure and Development.

Reproductive.

Fertilization in Fritillaria pudica.*—K. Sax finds this species exceptionally good for the study of the process of fertilization. Strong chromacetic acid and Flemming's stronger solution were used as fixatives. Most of the sections were cut 10 μ thick, but a few 15 μ and 20 μ; they were stained with modifications of Flemming's triple stain and with safranin and lichtgrün. The results obtained may be summarized as follows:—In the mature embryo-sac of *Fritillaria pudica* the egg-cell cannot be distinguished from the other two cells of the egg-apparatus. The "Endospermanlage" extends up between and around the cells of the egg-apparatus. The pollen-tube usually turns along the outer wall of the nucellus or embryo-sac before entering. At this time the cells of the egg-apparatus are all intact. The pollen-tube practically always enters and at least partly destroys one synergid. Although a distinct appearance of motility is evident in many male nuclei, the majority do not suggest much motility. The male nucleus and the egg nucleus fuse completely before division. The upper polar nucleus, with the male nucleus in contact with it, migrates to the lower one, probably cytoplasmic streaming. The two polar nuclei and male nucleus fuse completely, and the subsequent division is normal. The two red bodies, the "X-Korper" of Nawaschin, which remain in the pollen-tube after the male nuclei have been discharged are probably nuclei, and correspond to the two vegetative nuclei described in the pollen-tube before the two male nuclei were discharged.

CRYPTOGAMS.

Pteridophyta.

(By A. Gepp, M.A., F.L.S.)

Acrostichoid Ferns.†—F. O. Bower, continuing his studies in the phylogeny of the Filicales, publishes his sixth contribution, "Ferns showing the 'Acrostichoid' condition, with special reference to Dipteroid Derivations." He gives the following summary of the chief results

* Bull. Torrey Bot. Club., xliii. (1916) pp. 505–22 (3 pls.).
† Ann. Bot., xxxi. (1917) pp. 1–39 (2 pls. and figs.).

obtained : 1. *Cheiropleuria*, *Platycerium*, and perhaps *Neocheiropteris*, share with the fern hitherto styled *Leptochilus tricuspis* (Hook.) C. Chr., an extension of the sorus, with a special vascular supply, spreading in a plane below and parallel with the venation of the sporophyll. This is most extensive in *Platycerium* and *L. tricuspis*, and the condition may be described as *diplodesmic*. 2. These ferns, in external morphology, venation, anatomy, sorus, and sporangia, are regarded as Dipterid derivatives, and may be grouped phyletically as Dipteroideæ. To these may probably be added, later, many Polypodioid ferns, especially *Phlebodium*, *Phymatodes*, *Niphobolus*, and *Drynaria*, and some simple-leaved species of *Leptochilus*. 3. *L. tricuspis* stands alone in the latter genus in various features, but especially in the diplodesmic character. It should, therefore, be removed, and by reviving its old generic name, now merged in *Leptochilus*, it may be styled *Gymnopteris tricuspis* (Hook.) Bedd. Of that genus it will be at present the only species. 4. A parallel series to the Dipteroideæ, but differing in venation, and probably distinct phyletically, is related to *Metaxya* as its probable source. It includes *Syngramme* and *Elaphoglossum*. These may be styled the Metaxyoideæ. 5. Both of these progressions illustrate advance from circumscribed sori to an "Acrostichoid" spread of the sporangia over the leaf-surface. This runs parallel with changes of leaf-form, disintegration of the vascular tracts, passage from dermal hairs to scales, increasing areolation of veins, and changes of sporangia from the continuous oblique to the interrupted vertical annulus. Since there is substantial parallelism in these various characters of advance, the progressions are firmly established; but they are constantly distinguished from one another by their venation. 6. The genus *Leptochilus*, as at present defined, may probably be a composite genus, not a phyletic unity. 7. The "Acrostichoid" condition has been acquired along a very considerable number of distinct phyletic lines. Accordingly *Acrostichum* connotes not a genus in the sense of a phyletic unity, but a condition or state, which has been arrived at from various distinct sources.

Leaf-trace in Pinnate Leaves of Ferns.*—R. C. Davie publishes the results of his investigation of the leaf-trace in some pinnate leaves—viz. fronds of South American and Scottish species of *Polypodium* collected from stations representing very different conditions. The leaf-traces and pinna-traces of these and of species of *Aspidium*, *Polystichum*, *Dryopteris*, *Leptochilus* and other genera were examined and compared. The author states that the habitat of the fern was not found in any case to influence the type of leaf-trace or pinna-trace. In a few species of *Polypodium* the habitat was found to have an effect on the number of tracheides in the leaf-trace. The type of pinna-trace is constant within a genus, recognized as such in Christensen's *Index Filicum*; the form of the leaf-trace is dependent on the length of the leaf and the size of the pinnæ. The form of the adaxial portion of the leaf-trace is constant throughout a genus; the degree of development of

* Trans. Roy. Soc. Edinburgh, lii. (1917) pp. 1–36 (1 pl. and figs.).

the abaxial curve depends on the length of the leaf and the size of the pinnæ. In Cycads the abaxial portion of the leaf-trace is directly connected with the length of the leaf; and in most genera the pinna-trace is supplied from the adaxial margin of the leaf-trace nearest to the pinna. In some of the Palmaceæ the forms of leaf-trace and pinna-trace are directly related to the type of vascular system found in the stem, and appear to be independent of the size of leaf and the manner of its development. In Dicotyledons two distinct types of leaf-trace, with their varieties, have been found. The type of leaf-trace with strands forming a ring is found in woody plants, excepting those with basipetally-developed leaves; the type open on the adaxial face is found in herbaceous and woody plants with basipetally-developed leaves; in herbaceous plants with acropetally-developed leaves the "open" type of leaf-trace is provided with an intramedullary reinforcing system. The factors which control the form of leaf-trace and its system of branching are:—(1) Systematic position; (2) the length of the leaf and the size of its appendages; (3) the order of development of the pinnæ; (4) the type of vascular system found in the stem. Among Ferns (1) and (2) are operative; (1), (2) and (3) among Cycads; (4) among Monocotyledons; and (3) and (4) among Dicotyledons.

Lycopodium prothallia from New Zealand.*—C. J. Chamberlain publishes an account of the prothallia and sporelings of three New Zealand species of *Lycopodium*, prefaced by a historical résumé of papers previously published on *Lycopodium* prothallia. The present paper treats of material supplied by A. P. W. Thomas of Auckland—*Lycopodium laterale*, *L. volubile*, and *L. scariosum*. Summarizing his results, the author says:—1. *Lycopodium laterale* has a green, leafy prothallium; and there is a protocorm-protophyll stage in the embryogeny. *L. volubile* and *L. scariosum* have subterranean prothallia with no protocorm stage, but the early leaves have the structure of protophylls. 2. In *L. scariosum* and *L. volubile* the sporeling has a radial stele. The adult plants have a banded stele. 3. The outer part of the ray of the radial structure consists almost exclusively of pitted tracheids with scarcely any spiral vessels, but becomes lignified long in advance of the large tracheids of the metaxylem, and should be regarded as the protoxylem.

Lycopodium prothallia in America.†—E. A. Spessard announces his discovery of prothallia of *Lycopodium* in America after a prolonged and careful search in Michigan, and describes the conditions under which the specimens (twenty-one prothallia and over fifty sporelings) were found. The prothallia of *L. obscurum* and *L. lucidulum* were previously unknown; the other species found were *L. complanatum*, *L. clavatum* and *L. annotinum*. In order to prove that he is describing genuine prothallia, he gives figures of the structure, showing antheridia, archegonia, and the fungus-infected region.

* Bot. Gaz., lxiii. (1917) pp. 51–65 (2 pls.).
† Bot. Gaz., lxiii. (1917) pp. 66–76 (figs.).

Maxonia, a New Genus.* — C. Christensen founds a new genus, *Maxonia*, upon the single species *Polystichum apiifolium* (Sw.) C. Chr., which has structural characters intermediate between *Dryopteris* and *Polybotrya*. It differs from *Dryopteris* in having a creeping rhizome, dimorphous leaves, a different kind of pubescence, and an indusium of peculiar development. From *Polybotrya* it differs in having dorsal sporangium which are confined to the veins, in being less dimorphous, and in possessing an indusium. It occurs in Jamaica, Cuba, and Guatemala, and has nothing to do with the *Polybotrya apiifolia* J. Smith found in the Philippine Islands.

Amboina Pteridophyta.†—C. R. W. K. van Alderwerelt van Rosenburgh publishes an account of the ferns collected by the late C. B. Robinson in Amboina, whose object was to collect a series of specimens representative of the forms actually described by Rumphius in the "Herbarium Amboinense" (1741–55). The list contains seventy-seven species and several varieties, including eight which are new to science. Appended is a list of the forty-seven Pteridophyta described by Rumphius, with their modern equivalents, so far as they have been determined. Figures illustrating the structure of new species of *Trichomonas* and *Drymoglossum* are given.

Hawaiian Ferns.‡—E. B. Copeland, having examined the ferns of the College of Hawaii herbarium, publishes descriptions of five new species belonging to the genera *Athyrium*, *Sadleria*, *Pteris*, *Elaphoglossum*, *Polypodium*, and adds critical notes which clear away difficulties in connexion with certain variable and incorrectly determined forms. The novelties were all collected by J. F. Rock.

Madagascar Ferns.§—H. V. Rosendahl describes and figures four new species of ferns collected in Madagascar by Mrs. K. R. Afzelius and B. T. Palm during the Swedish Madagascar Expedition of 1912–13. The locality given is Moramanga; and the genera concerned are *Adiantum*, *Asplenium*, *Diplazium*, and *Odontosoria*.

C. Christensen ‖ also describes and figures some new ferns from the same collection—five new species of *Dryopteris* and two of *Asplenium*—adding critical notes in English.

Bryophyta.

(By A. Gepp.)

Fossil Camptothecium.¶—A. J. Grout describes and figures a remarkably well-preserved moss found during the sinking of a well, at

* Smithsonian Misc. Coll., lxvi. No. 9 (1916) pp. 1–4.
† Philippine Journ. Sci., xi. Sect. C (1916) pp. 101–24 (2 pls.).
‡ Philippine Journ. Sci., xi. Sect. C (1916) pp. 171–3.
§ Arkiv f. Botanik, xiv. No. 18 (1916) 5 pp. (3 pls.).
‖ Arkiv f. Botanik, xiv. No. 19 (1916) 8 pp. (2 pls.).
¶ Bryologist, xx. (1917) p. 9 (1 pl.).

a depth of 80–90 ft., in the Kansan Drift of Iowa. The plants are green, and show all the details of cell-structure. It is clearly a *Camptothecium*, but corresponds with no existing American species; it is accordingly published as a new species, *C. Woldenii*, differing from *C. pinnatifidum* and *C. aureum* in its entire leaves and very few isodiametric alar cells.

North American Hepaticæ.*—A. W. Evans publishes a seventh chapter of "Notes on North American Hepaticæ." An important addition to the flora is *Bucegia romanica*, a thalloid genus found in Rumania in 1897, and first described by Radian in 1903, later collected in the Tatra Mountains of Hungary, and subsequently gathered at altitudes of 7200–8800 ft. in Alberta and British Columbia by A. H. Brinkman. Though Brinkman's specimens are sterile, they are obviously to be referred to *Bucegia* because of the structure of the thallus, which has dolioform stomata like those of *Marchantia*, but approaches *Reboulia* in respect of its air-chambers and synthetic tissue. Another plant new to the North American flora is *Fossombronia lamellata* Steph., recently gathered in Florida by S. Rapp, and remarkable for its well-differentiated tubers, which are discussed and figured in the present paper. It has a wide distribution in South America, and is synonymous with *F. tuberifera* Goeb. Critical notes on the inflorescence of *Jungermannia Schiffneri* Evans, the structure of *Cephalozia Loitlesbergeri* Schiffn., and of *Cololejeunea subcristata*, a new species discovered in Florida, are important features of the paper.

Portuguese Hepaticæ.†—A. X. P. Coutinho publishes an account of the Portuguese Hepaticæ in the herbarium of Lisbon University, comprising sixty-eight species, from collections made by himself, Welwitsch, Luisier, and others. He gives a Latin description of each species, the local distribution, the principal references to literature, and a key to the genera. He adds nine species to the Portuguese flora.

Thallophyta.

Algæ.

(By Mrs. E. S. Gepp.)

Phytoplankton of the Antarctic.‡—L. Mangin publishes a full report on the collections of phytoplankton made by M. Gain on the second French Antarctic Expedition in the "Pourquoi pas?" 1908–10. The first part of the report consists of a list of the stations, with an enumeration of the species found there, together with an estimate of

* Bryologist, xx. (1917) pp. 17–28 (1 pl.).

† Hepaticæ Lusitanicæ. Lisboa: M. L. Torres (1917) 39 pp.

‡ Deuxième Expédition Antarctique Française (1908–10). Phytoplancton de l'Antarctique. Paris: Masson (1915) 96 pp. (3 pls., map, and 58 figs.).

their frequency. The same lists are also shown in tabular form. The second part of the report is devoted to special observations on the most interesting species, collected with a few exceptions between 65° S. lat. and 70° S. lat. The species are discussed in great detail and figured, and new ones are described. The third part is entitled "General Observations," and in it the author discusses distribution, in depth, seasonal, and geographical. An examination of the samples of the various stations shows that the different groups of stations may be distinguished by their respective floras. The various groups are discussed from this aspect, and from the point of view of depth. The author then summarizes his conclusions on the characters of the Antarctic plankton flora, and gives a comparison of the floras of the Arctic and Antarctic regions. The phytoplankton consists principally of Peridiniales, Diatomaceæ, and a few Schizophyceæ, the last being a new record for the Antarctic. Peridiniales, in sharp contrast to the Arctic regions, are very rare in the Antarctic. *Ceratium* is entirely absent, and *Peridinium* is only represented by a few small species, among them being *P. pellucidum*, which is common to the two regions. Diatomaceæ are the principal constituents of the Antarctic flora. In the present paper the number of species added to the already recorded diatom flora of the Antarctic brings the total up to about 220 species, of which six are described as new. The characteristic species is *Corethron valdiviæ*, which occurs in every sample except one, and in many of them is of great abundance. It is essentially a summer species, abounding from December to the end of April; very rare from May to the end of October. *Coscinodiscus* flourishes from October to January, the spring-time. The same may be said of *Eucampia antarctica* and *Biddulphia striata*; while *B. polymorpha* and *Melosira Sol* are more autumn and winter species. The author discusses shortly regional variations. A detailed comparison of the Arctic and Antarctic floras shows that eleven genera are common to both regions, and thirty-one species, of which latter all, except five or six, are more or less cosmopolitan.

Pinnulariæ.*—C. Jones writes on the Secondaries or dotted structure in Pinnulariæ. He discusses shortly the views of H. J. Slack and the photograph of *Pinnularia nobilis* produced by T. A. O'Donohoe, and then gives his own conclusions on the subject as the result of an examination of his own material. He is of opinion that finding the dots is not a matter of resolution as ordinarily understood, but rather of rendering them more conspicuous, except, perhaps, in some of the smaller valves. The dots are not immediately connected with the costæ, as Slack and others appear to have assumed. When viewing a valve in the ordinary way—that is, with its outside or convex side uppermost—it appears that there is a dotted membrane under the costæ, and a non-dotted, if not structureless, membrane over the costæ, and that the dots are generally hidden by this upper membrane, unless special means are taken to render the dots conspicuous. This dotted membrane appears to be attached, at least in some cases, to the girdle. This accounts for its absence from some valves. On the other hand, it is sometimes

* Journ. Quekett Micr. Club, xiii. (1916) pp. 107–10 (figs.).

attached to the costæ. Perhaps there is a strip of dotted membrane attached to or forming a part of the girdle, and other dotted membranes attached to the costæ, but he has no direct evidence of this. He holds that the dots are concavities, as one might expect by analogy, because fracture takes place across them, and when seen sideways on the rounded edge of a curved membrane the curve of the concave outline is obvious. Five photographic figures illustrate the author's contentions.

Chlorochytrium grande.*—B. Muriel Bristol gives an account of the life-history and cytology of *Chlorochytrium grande*, a new protococcaceous alga, collected in a dyke in West Yorkshire. She gives the following summary of her results:—1. In rain-water rapid multiplication of the plant takes place by means of aplanospores, and the cells are thin-walled. In mineral salt-solutions aplanospores are formed more rarely, and the cells become converted into large zoogonidangia with very much thickened walls. In distilled water an enormous thickening of the walls takes place. 2. The vegetative cells are spherical, subspherical, or ellipsoid, 65–75 μ in diam., with a wall of fairly uniform thickness consisting of an inner cellulose and an outer pectic layer. They contain a wide-meshed cytoplasmic reticulum, with a large central nucleus and a single massive chloroplast, which is raised into numerous rounded lobes at its surface and occupies practically the whole cell except the nucleus. The cells contain oil, numerous granules of starch, and a variable number of pyrenoids. 3. Propagation takes place by simultaneous division of the contents of a cell into aplanospores, preceded by numerous successive mitotic divisions of the nucleus of the cell. The chromatin of the resting-nucleus is in the form of a karyosome. 4. The zoogonidangia are very large, averaging 130 μ in diam. The wall bears one to two rounded external pectic projections, and one to several internal cellulose projections which are frequently large and may be branched within the cytoplasm, which is correspondingly distorted. Starch, oil, and pyrenoids are all present. 5. Zoogonidia-formation takes place by the successive bipartition of the contents of the mother-cell into numerous biciliate oval or pear-shaped bodies, which escape through a vesicle in the zoogonidangium wall. They develop directly into vegetative cells. 6. The alga is established as an independent species on account of the very large size of the zoogonidangium and the great thickness and irregularity of its wall. 7. The generic names *Endosphæra* Klebs (1881), *Scotinosphæra* Klebs (1881), *Centrosphæra* Borzi (1883), are unnecessary, since the algæ thus named can quite satisfactorily be included within the single genus *Chlorochytrium* Cohn (1874); and the generic distinctions put forward by Klebs and Borzi are inadequate for their retention as independent genera. The new species described has therefore been named *Chlorochytrium grande*, rather than *Centrosphæra grandis*. 8. *Phyllobium sphagnicola* is a cœnocyte, containing a reticulate mass of cytoplasm in which are embedded numerous small granules of chromatin, and in the meshes of

* Ann. Bot., xxxi. (1917) pp. 107–26 (2 pls. and figs.).

which there are a very large number of pyrenoids. The chlorophyll is probably diffuse throughout the cytoplasm. The cells of the branching thallus appear to have no contents.

Fresh-water Algæ of New South Wales.*—G. I. Playfair publishes a census of New South Wales fresh-water algæ, as a supplement to Maiden and Betche's "A Census of New South Wales Plants" (1916). He follows the classification used in G. S. West's "British Freshwater Algae" (1904), and in his introduction summarizes the differences between this classification and that in Engler's "Syllabus der Pflanzenfamilien" (1904). The latter system is inadequate and incomplete. Playfair's census contains six genera of Phæophyceæ, forty-eight of Chlorophyceæ, twenty-three of Desmidiaceæ, four of Heterokontæ, thirty-nine of Bacillarieæ, twenty-one of Myxophyceæ. And, adding all the species, varieties, and forms together, we find a total of 1061. Further, there are three genera of Phycomycetes and six of Schizomycetes, with a combined total of twenty-eight species, varieties, and forms. And most of them the author has collected and identified personally.

Algal Ancestry of the Higher Plants.†—F. E. Fritsch, in discussing the Algal ancestry of the higher plants, gives the following summary :—1. In all the more advanced groups of the algæ, the thallus exhibits frequent differentiation into a creeping base and an upright system. 2. Among the Chætophorales, which plainly show such a differentiation of the thallus, there are evidences of unlimited potentialities ; we also find in this group—(*a*) a whole series of terrestrial forms ; (*b*) the only member of the Isokontæ with a distinct main axis bearing laterals which carry on assimilation and reproduction ; and (*c*) in the species of *Trentepohlia*, forms showing relegation of the sexual organs to the base, and of asexual organs to the upright system. 3. The available evidence is regarded as pointing to the Isokontæ for the ancestry of the higher plants, and, for the reasons mentioned under paragraph 2, this ancestry is thought to lie among forms resembling the Chætophorales. 4. The Pteridophyta are supposed to have arisen from such forms by the gradual divergence of two generations, the sexual derived from the creeping base, the asexual from the upright system. The Bryophyta are supposed to have arisen from forms resembling *Coleochæte* by gradual elaboration of the zygote. 5. *Cutleria*, in a side-line of evolution, fully illustrates the way in which two generations can be derived from the type of thallus common in all the main groups of the algæ, after the manner postulated for the case of the Pteridophyta. 6. The cases of alternation among the algæ may be distinguished as follows :—(*a*) The two generations arise from different parts of the ancestral sporo- and gameto-genetic thallus (*pseudo-homologous alternation*) : (1) The gametophyte is prostrate, the sporophyte erect (Pteridophyta, possible cases to be found among the Chætophorales) ; (2) the

* Census of N.S. Wales Plants. Supplement I. Fresh-water Algæ. Sydney: Gullick, 1917, pp. 217–63.

† New Phytologist, xv. (1916) pp. 233–50 (figs.).

gametophyte is erect, the sporophyte prostrate (*Cutleria*). (*b*) The two generations arise from the same part of the ancestral thallus, the other portion aborting (*strictly homologous alternation*): (1) The two generations arise from the upright system (*Dictyota*); (2) the two generations arise from the prostrate system (*Zanardinia ?*). (*c*) The sporophyte arises as an intercalated stage in the life-history, due to the elaboration of the zygote (*antithetic alternation*): (1) The gametophyte arises from the prostrate system (*Coleochæte*, Hepaticæ); (2) the gametophyte arises from the erect system (Nemalionales); (3) the gametophyte retains both the prostrate and erect systems (*Batrachospermum*, Musci). (*d*) There are two spore-producing generations, the one an intercalated phase produced from the zygote, the other strictly homologous (*Polysiphonia*, *Griffithsia*, and other advanced Florideæ).

Galaxaura obtusata.*—M. A. Howe publishes a note on the structural dimorphism of sexual and tetrasporic plants of *Galaxaura obtusata*. In the section of *Galaxaura* to which *G. obtusata* belongs, two groups have been recognized, "Cameratæ" and "Spissæ." The plants of these two groups differ markedly and constantly in the structure of the cortex, which consists of three layers of cells. These are described fully by the author. Briefly expressed, it may be said that the two outer layers of the cortex in the Cameratæ are filamentous, while in the "Spissæ" the cortex is parenchymatous or subparenchymatous throughout. In the course of a microscopic examination of specimens of *Galaxaura* from Bermuda, Florida, and the West Indies, representing forms referred to *G. obtusata*, it was found that some plants showed the cortex structure of the "Cameratæ," and others that of the "Spissæ"; and that the difference in cortical structure corresponded with the difference of reproductive organs, whether sexual or non-sexual. Plants of the "Cameratæ" structure were always tetrasporic, while those of the "Spissæ" structure were always antheridial or cystocarpic. This held good for all plants in all the collections examined. The author believes that no such constant and pronounced dimorphism in the purely vegetative microscopic structure of sexual and tetrasporic plants has ever been recorded in Rhodophyceæ. A sexual plant may thus be distinguished from a tetrasporic one, even though apparently sterile.

Fossil Lithothamnium.†—C. Samsonoff Aruffo describes a new species of *Lithothamnium* from the Post-pliocene of Brindisi. It occurs sometimes in the form of a crust, and sometimes (more often) as a ramifying form. The alga forms crusts of about a millimetre thick round shells of *Turritella*, making a model of the shape. The crusts are not stratified or zoned, and are often superposed. More often the alga is branched, the branches being short and thick, sometimes noduliform, with frequent bifurcations. The tips of the branches are often swollen and clavate, rounded, never acuminate. The habit of the alga is difficult to determine, owing to its great friability, but it appears that

* Bull. Torrey Bot. Club, xliii. (1917) pp. 621–4.
† Atti R. Accad. Lincei Roma, ser. 5, xxv. (1916) pp. 495–8.

individuals of mediocre dimensions are united together in great numbers. The anatomical structure points to the inclusion of the species in *Lithothamnium*, in which its nearest ally is *L. compactum* Kjellm., which has both crustaceous and branching forms. The author proposes to name the present Post-pliocene form, f. *ramulosa*. It is nearer to f. *typica* than to the other forms. The author discusses the distribution of *L. compactum*, which is a northerly one, and puts forward possible explanations for its occurrence at Brindisi in Post-pliocene times.

Saccorhiza bulbosa.*—C. Sauvageau writes on the annual periodicity of *Saccorhiza bulbosa*, in contrast to other Laminariæ which are perennial. He has followed its life-history at Guéthary (Basses-Pyrénées) during several years, and finds the evidence indisputable. *S. bulbosa* attains its greatest size in July; then gradually diminishes owing to wear and tear and probable cessation of growth. The fructification appears in August, but is rare. In October many plants are fertile on the stipes and the frond, dispersing a prodigious number of zoospores. All the divisions of the frond are cropped short and truncated, in large as well as poorly-developed plants, fertile as well as sterile. This is apparently a seasonal phenomenon, and is aided by the attacks of *Helcion pellucidum*. Towards the end of the autumn the plant is reduced to its bulb, which up to then has been sterile. In February or the beginning of March the bulbs are often fertile, though more or less damaged. In April they entirely disappear. The first plantlets appear in the second fortnight of February; the others in March and April. All grow rapidly, and one finds no more till the following year. Thus the entire development of *S. bulbosa* is accomplished in a few months. The plantlets are found during three months only, while the emission of zoospores lasts for seven consecutive months. The young April plants arise from zoospores recently emitted from the bulbs, not from old prothallia or resting embryospores; and the origin of the February plantlets is the same. Consequently, the sori on the bulbs suffice to reproduce the plant, and the spores which were formed during the autumn do not germinate in the open, though they germinate successfully under culture. Some adverse factor in nature prevents germination from the middle of the summer to the beginning of winter. The author discusses what this may be, but comes to no conclusion. In other localities he has found plants in all stages of development, notably at Rivadeo in October and at La Corogne at the beginning of November. The author describes the luxuriant growth of *S. bulbosa* both in size and extent at Roscoff, and the distinct impression of the gradual disappearance in September of the old specimens. Plants of all ages, however, may be found at other times of the year. At Roscoff the annual character of *S. bulbosa* is very clearly shown.

Plantlets of Laminaria.†—C. Sauvageau describes the development of the young plants of *Laminaria flexicaulis* and *L. saccharina*. In a former paper he described the developmental stages of plantlets of

* Comptes Rendus, clxiii. (1916) pp. 396–8.
† Comptes Rendus, clxiii. (1916) pp. 522–4 (figs.).

Saccorhiza bulbosa. They differ somewhat from those of *L. flexicaulis* and *L. saccharina*, which are here described in detail and figured. The transverse divisions of the elongated embryo appear without any fixed order. The first is approximately median; and as the two cells thus formed and their daughter-cells divide simultaneously or successively, the embryo possesses a number either even or odd of cells, which by enlarging determine the future plan of the frond. Their relative age, less distinct in surface view, can always be recognized in profile, even in older plants. One transverse wall, sometimes the third formed, but generally a later one, separates off a flattened basal cell, from which arise the first rhizoids. Soon a longitudinal division appears in the central region, then in all the cells, simultaneously or unequally towards the apex or the base. Two successive divisions crosswise arise then in each of these cells, and so on more or less regularly. The basal portion divides more slowly and remains therefore attenuated, but the proper distinction between stipes and frond is not possible till a later stage. The lower part thickens more rapidly by means of tangential divisions, while the upper and longer part remains monostromatic. The differentiation of the generative zone is therefore later, and less strictly localized than in *S. bulbosa.* The median region of the monostromatic plantlets of *L. flexicaulis* reaches generally a greater width than that of *L. saccharina.* The first rhizoid, which often penetrates into the cavity of the oogonium, becomes closely applied to its wall, which the succeeding rhizoids enclose and gradually cover. The lower cell of the embryo produces two or three rhizoids after longitudinal division, the separated cells successively producing the rest. All of them are undivided, thus differing from those of *S. bulbosa.* At no stage of development are there any subapical initial cells of the frond, as described by Yendo for the Japanese species. The author finds that the arrangement of the subapical layers gains in regularity while their capacity for division diminishes and the apex attenuates. Intercalary division is generally dispersed and causes the growth in length and width of the frond. There is no question of marginal meristem. This is more clearly to be seen in *L. flexicaulis*, where the meshes of the muciferous net are larger. The cell-division of the embryos and plantlets of *Alaria esculenta* is similar to that of *L. saccharina* and *L. flexicaulis.* These three species differ from *Saccorhiza bulbosa* in the slower differentiation of the intercalary generative zone.

Marine Algæ of Malmö.*—D. E. Hylmö has made a careful study of the green marine algæ occurring in the neighbourhood of Malmö in Sweden and publishes his results. The first part of the paper is devoted to an enumeration of the species with critical notes. In the second part he deals with general considerations:—The life-conditions, including depth, composition of the substratum, salinity; algæ formations, of which he recognizes seven; seasonal changes; comparison between the vegetation (green algæ) of Malmö and that of surrounding districts. This comparison, in the author's opinion, is neither wholly satisfactory

* Arkiv f. Botanik, xiv. (1916) No. 15, 57 pp. (3 pls.).

nor final, since many genera of the green algæ are still in need of a clear systematic investigation.

Antarctic Marine Algæ.*—A. and E. S. Gepp and Madame Paul Lemoine publish a report on the small collection of marine algæ collected by the "Terra Nova" Expedition to the Antarctic in 1910. The former authors record eighteen species, the most interesting of which is *Chrysymenia obovata* from South Trinidad, previously only known from the southern and western coasts of Australia. The opportunity is taken to point out the probable identity of the author's unknown "Floridea," collected by Dr. Rudmose Brown in the South Orkneys in 1903, with the *Curdiea Racovitzæ* Hariot, collected by the French Antarctic Expedition and published in 1912. The Melobesieæ of the "Terra Nova" Expedition are determined by Madame Paul Lemoine. Only two species were found, and both are new: the one dredged from a depth of 30 m. off the North Cape of New Zealand, and the other from South Trinidad. The habit and structure of both species are fully described and figured.

Fungi.

(By A. Lorrain Smith, F.L.S.)

Study of Saprolegnia.†—P. A. Dangeard describes the nature and habitat of this genus of aquatic facultative parasites. In order to determine the species it is necessary to have the sexual organs; the species he experimented with bore no oogonia, so it is only doubtfully that he refers it to *S. ferax*.

He found that the cytoplasm formed a parietal layer, the centre of the filament being occupied by a long vacuolar canal. This parietal layer is thicker at the extremity of the branches, or the tips may be entirely full of cytoplasm. It is homogeneous and colourless, and contains minute refracting spherules or microsomes, mixed with oleaginous globules. The nuclei are spherical or ellipsoid and refractive, particularly the large nucleolus. There are also present in the cytoplasm other bodies in the form of spheres, rods or long filaments refractive and homogeneous; these he considers to be "mitochondries" or "chondriocontes." Dangeard gives the results of his experiments in staining the cytoplasm and these various bodies, and he discusses their origin, their activity, and their relation to the plant.

Endothia parasitica and Related Species.‡—Great attention has been given to this fungus since it originated the epidemic of canker disease of the chestnuts in America, and there has been considerable

* British Antarctic ("Terra Nova") Expedition, 1910. Natural History Report, Botany, pt. ii. (London, 1917) pp. 17–28 (figs.).

† Bull. Soc. Mycol. France, xxxii. (1916) pp. 87–96.

‡ U.S. Dept. Agric., Bull. No. 380 (1917) 82 pp. (23 pls. and figs.).

confusion as to the identity of several related species. C. L. Shear, Neil E. Stevens and Ruby J. Tiller now publish a thorough study of the whole group. There are seven such species, most of them parasitic, both in the pycnidial and perithecial stages, and several of them described long ago as *Sphæria gyrosa*. The author gives an exhaustive list of the synonymy of each species.

The mycelium of *Endothia parasitica* is remarkable in that it spreads in a yellow or buff fan-shaped formation in the bark and cambium of the host. The host-cells at the edges of the fan are disintegrated and form a distinct gelatinous band which suggests toxic or enzymatic action upon the host-cells, probably before they are invaded. Towards the outside, stromata are developed which finally rupture the epidermis, and in these are embedded the pycnidia and perithecia. The stroma of all the species is yellow to reddish in colour.

Endothia gyrosa they consider to be the type of the genus which is divided into two sections chiefly by the character of the ascospores; there are no paraphyses present. Cultures of the different species were made; they grew equally well in light or darkness.

Endothia parasitica, the most actively parasitic of all the species, has been found on *Acer*, *Carya*, *Castanea*, *Quercus* and *Rhus*, but at present is only known as a serious parasite on *Castanea*, and on American chestnuts is actively parasitic under all the conditions of soil and climate observed. Oriental species of *Castanea* are more or less resistant to the disease, both in America and their native homes.

Spore Germination in Onygena equina.*—It had been found by Marshall Ward and others that the spores of species of *Onygena* would not germinate until they were treated with gastric juice. W. Brierley has made exhaustive cultural experiments of the various reproductive bodies of *O. equina*, and he finds that the ripe ascospores will germinate after a prolonged resting period; a vigorous growth was obtained from such spores in glue and gelatin (only a few germ tubes in water). They develop after a much abbreviated resting-time when treated with gastric juice. Unripe ascospores and chlamydospores germinated immediately in suitable solutions in the absence of digestive treatment.

Plectodiscella veneta.†—W. H. Burkholder, while studying the anthracnose of the raspberry caused by *Glœosporium veneta*, found, as a further growth on the stroma of the *Glœosporium*, an ascigerous form consisting of a stroma-like body, very small and pulvinate; the tissue of the structure is plectenchymatous, the outer layer composed of thick-walled brown cells, this layer splitting apart as the stroma matures. The asci are scattered irregularly through the fungus tissue; there is no differentiated hymenium. Burkholder recognized its affinity with *Plectodiscella Piri*, an epiphytic fungus. Inoculation experiments from the ascospores reproduced the *Glœosporium* stage.

* Ann. Bot., xxxi. (1917) pp. 127–32.
† Phytopathology, vii. (1917) pp. 83–91 (3 figs.).

Agyrium flavescens.*—M. and Mme. Fernand Moreau have made a study of this Discomycete, parasitic on the thallus of *Peltigera polydactyla*. It grows on the under surface of the thallus among the somewhat loose hyphæ of the lower medulla. The hyphæ of the parasite are easily distinguished from those of the lichen by their much smaller dimensions; they occupy the spaces between the lichen hyphæ and do not form haustoria. The mature fruiting body has no distinct excipulum, but it is surrounded by a layer of dead lichen cells. The authors add that an amœba inhabits the same lichen and lives on the parasitic *Agyrium*.

Note on a Parasitic Saccharomycete.†—Albert Schneider follows up his previous account of this fungus, which grows on tomatoes, by the determination and diagnosis of the *Saccharomycete*. He now places it in the genus *Nematospora* Peglion, as *N. Lycopersici*. It bears a strong resemblance to *N. Coryli*, both species being true parasites on the plants of warm countries (South Italy, South California and Cuba).

Aspergillus Amstelodami.‡—This fungus was discovered in cultures at Amsterdam, and is distinguished from the nearly related *A. glaucus* by the smaller spores. Paul Vuillemin finds reason for suspecting that this fungus may be a parasite of the human body. It was taken from a patient and cultured on artificial media. The fungus is fully described.

Aspergillus fumigatus.§—A. Ch. Hollande and J. Beauverie describe the development of this fungus found in the expectoration of a patient suffering from breathlessness of asthmatic nature. The fungus, which existed in the mycelial condition, was isolated and cultivated, and the heads and spores of *Aspergillus fumigatus* were produced in abundance.

Amyloid of the Ascus as a Reserve Substance.‖—Fernand Moreau gives his observations on the portion of the ascus that in some genera of Discomycetes becomes blue on the application of potassium iodide. Frequently the amyloid is deposited as a ring round the tip of the ascus and aids in the expulsion of the spores, but in some instances the substance is gradually used up as the spores mature, and in such asci there is no colour reaction with iodine. Moreau notes particularly the amyloid in *Peltigera*, which occupies the tip of the ascus like a cylindrical cork, and at maturity is shot out to allow the escape of the spores.

Spicaria Parasitic on a Myxomycete.¶—Fernand Moreau has determined a new species of *Spicaria*, which was found by Dumée,

* Bull. Soc. Mycol. France, xxxii. (1916) pp. 49–53 (3 figs.).
† Phytopathology, vii. (1917) pp. 52–3.
‡ Comptes Rendus, clxiv. (1917) pp. 347–50.
§ Bull. Soc. Mycol. France, xxxii. (1916) pp. 17–24 (4 figs.).
‖ Bull. Soc. Mycol. France, xxxii. (1916) pp. 25–6.
¶ Bull Soc. Mycol. France, xxxii. (1916) pp. 33–6 (figs.).

forming a white coating over *Fuligo septica*. The vegetative and reproductive characters of the fungus are described and figured, and a comparison is made with another species, *S. penicillata*, described by Von Höhnel as a parasite on another Myxomycete, *Arcyria punicea*, and with *S. perpusilla* Speg., which was found on *Hemiarcyria calyculata*. Moreau states the differences which he considers are specific ; the new species is called *Spicaria Fuligonis*.

Uredineæ.—W. A. McCubbin* has instituted an enquiry as to the over-wintering of *Cronartium ribicola* on currant-bushes. The æcidium, or *Peridermium* stage, occurs on white pines, and as the disease reappeared in localities where infection from pines seemed impossible, it was concluded that there must be over-wintering of the rust mycelium in the currant. The author does not consider that the evidence to hand has entirely established the fact of over-wintering. The infection really depends on the distance to which the æcidiospores could be carried by the wind ; "if only for a mile or two, their wintering on the currant has almost certainly taken place in the area under consideration." More knowledge is desired on spore dispersal.

An account is also published of *Cronartium Comptoniæ*, the uredospores of which grow on *Comptonia asplenifolia* and *Myrica Gale*, while the æcidiospores are borne on species of *Pinus*. Perley Spaulding† gives a list of other species of *Myrica* which he inoculated with æcidiospores from the pine, but failed to secure any infection. The Uredine has proved disastrous to several pines, more especially to *Pinus ponderosa* and *P. contorta*.

G. G. Hedgcock and W. H. Long‡ have produced the æcidia of *Peridermium carneum* on young trees of *Pinus heterophylla* by inoculating them with teleutospores of *Coleosporium elephantopodis*. They further proved that *Vernonia* was a second host for the *Coleosporium*. The peridermium stage has been found on the leaves of a number of pine species.

G. G. Hedgcock and N. Rex Hunt§ have also proved the connexion between *Coleosporium* on species of *Ipomæa* and *Pharbitis* and a *Peridermium* on the leaves of *Pinus echinata*, *P. palustris*, and others. A large number of allied plants were inoculated with negative results. The same writers established the relationship between *Peridermium terebinthaceum* (on *Pinus echinata*, *P. rigida*, and *P. tæda*), and the *Coleosporium* teleutospores on plants of *Silphium* and *Parthenium* ; other plants, *Amsonia*, *Coreopsis*, and *Laciniaria*, were inoculated without results. They have found the æcidial form of *Coleosporium Helianthi* on *Pinus virginiana* ; the teleutospore, or *Coleosporium* stage, was determined in a large number of *Helianthus* species. New *Peridermium* hosts have been established for *Coleosporium Solidaginis* ; there are *Pinus* species such as *P. caribæa*, *P. contorta*, *P. divaricata*, etc.,

* Phytopathology, vii. (1917) pp. 17–31.
† Phytopathology, vii. (1917) pp. 49–51.
‡ Phytopathology, vii. (1917) pp. 66–7.
§ Phytopathology, vii. (1917) pp. 67–9.

extending over a wide range of territory. The only alternate hosts for this Uredine, so far as known, are *Aster* and *Solidago*. New hosts have also been discovered by inoculation methods for *Coleosporium delicatulum* and for *C. inconspicuum*; the latter has been collected for the first time on the needles of *Pinus echinata*.

J. C. Arthur * publishes a systematic account of the Uredineæ of Porto Rico, based mainly on collections of H. H. Whetzel and E. W. Olive. There were 383 numbered collections, which represented 122 species which have been duly listed and described. Most of the grass and sedge rusts in the island reproduce by uredospores alone. There was material enough in the collection to solve several problems of relationship and to suggest new relationships requiring further proof. One new genus, *Olivea*, was discovered in the family Melampsoraceæ; the uredosori expand from a minute sub-cuticular mycelium to a globose mass of strongly-incurved paraphyses united at the base; the spores are borne on pedicels and are obovate, stellately angular, and echinulate. An index of the species is added.

Ellsworth Bethel † has experimented with *Puccinia subnitens*, a common rust on *Distichlis spicata*. The æcidia had been proved as growing on several different hosts, and Bethel now publishes results of his inoculations proving that the æcidia grow on twenty-two species in six families and fifteen genera. He gives a list of these, and suggests that others may yet be added.

W. A. McCubbin ‡ has studied particularly the life-cycle of *Cronartium ribicola* on white pine, and has determined definitely the time required for its full development. He summarizes it thus:—First season, infection in summer and autumn; second season, dormant period; third season, swelling stage; fourth season, formation of æcidia. There is evidence, he finds, that the swelling stage may be prolonged during two seasons. The course of the disease thus involves five seasons, and, though it may mature in four years, it may be generally considered a five-year cycle.

New Melanospora.§—Marcel Mirande has maintained a pure culture of this fungus, obtained from spores collected on green plants. He has concluded from his examination that the species is new, and gives the name *M. mattiroliana*. He obtained not only perithecia and ascospores, but the conidial stage, belonging to the genus *Spicaria*. This latter genus of *Hyphomycetes* has never before been found as an integral part of *Melanospora* fructification, but in this instance perithecia and conidiophores arise on the same mycelium.

Harmful Agarics.‖—J. Chifflot reports the somewhat interesting case of a poison occurring in *Coprinus ailamentarius*, which induced

* Mycologia, ix. (1917) pp. 55–104.
† Phytopathology, vii. (1917) pp. 92–4.
‡ Phytopathology, vii. (1917) pp. 95–100.
§ Bull. Soc. Mycol. France, xxxii. (1916) pp. 64–73 (3 figs.).
‖ Bull. Soc. Mycol. France, xxxii. (1916) p. 63.

reddening of the skin when taken along with alcohol. There was no irritation, but the red coloration lasted several hours, and reappeared at the next meal if wine were partaken.

P. Dumée * has tested the toxicity of *Entoloma lividum.* He ate a portion of the pileus carefully prepared and cooked with butter for twenty minutes. Somewhat severe effects resulted, repeated sickness, wakefulness, etc., but the poison had no effect on the heart.

Lepiota from the Nests of Termite Ants.†—M. Patouillard describes a new fungus of this genus, *L. Le Testui*, from the Congo region, which is very near to *L. albuminosa* Berk. and Br., an Eastern species which occurs in a similar habitat. There are various differences between the species, such as the presence or absence of a ring, a long stalk, or one terminating in a root which may attain considerable length ; they differ in the appearance of the pileus, dry and hairy in the Congo plant, viscous in the plant from the East, and also in some other particulars. A diagnosis of the new species is given.

Clathrus cancellatus.‡—J. Chifflot reports the occurrence of this very rare fungus at Saint-Genis-Laval (Rhône). Two groups of the fungus were found in the soil ; from loose hyphæ there arose a thick mycelial cord about 3 mm. in diameter, which branched and bore at the tips of the branches one or two specimens of the fungus. The author sees good reason for considering that insects aid in the distribution of *Clathrus*, as when the spores are mature a powerful odour is emitted by the fungus which attracts the insects.

Anatomy of Agarics.§—A. Sartory draws attention to the increasingly recognized importance of histological characters in Agarics, and he gives details of a number of Tricholomas that he has examined. He finds quite determinable differences in the form of the spores, the radial section of the pileus, and in the surface of the pileus. *Tricholoma Georgii*, *T. nudum*, *T. chrysenteron* and *T. terreum* are the species dealt with so far.

New Parasitic Fungi.‖—B. C. Tharp, plant pathologist in the Texas Department of Agriculture, has collected and determined a large series of microscopic pathogenic fungi, all of them found on living leaves of various plants in his district. A very large percentage belongs to the genus *Cercospora*. Other genera represented are *Exosporium*, *Phyllostica*, *Ramularia*, *Septoria*, &c. Diagnoses are given and the host plant indicated.

* Bull. Soc. Mycol. France, xxxii. (1916) pp. 77–80.
† Bull. Soc. Mycol. France, xxxii. (1916) pp. 59–62 (1 pl.).
‡ Bull. Soc. Mycol. France, xxxii. (1916) pp. 55-8.
§ C.R. Soc. Biol. Paris, lxxix. (1916) pp. 1002-3.
‖ Mycologia, ix. (1917) pp. 105–28.

Fungi that Live on Paper.*—Pierre Sée has for some time given attention to the moulds that are found on damp paper. These are generally Hyphomycetes and leave a coloured stain on the paper. The spores have presumably been entangled with the substances of which the paper is made, and develop in suitable moist conditions. Sée has cultured these fungi on carrot, potato, gelatin, bread, etc. He finds that the same fungi recur frequently, and that the "paper fungus flora is a comparatively limited one."

Effect of Fungicides on Hop Mildew.†—E. S. Salmon has been experimenting on the effect of sulphur solutions on *Sphærotheca Humuli.* He does not agree with the opinion that the lethal agent is the sulphur deposited from the solutions used. It is the solution that kills the fungus. The fungus was easier to damage when in the conidial stage, possibly because the walls of the hyphæ are then thinner; they were also less resistant on an old hop-leaf than on a young one. If the fungus is to be killed at the early stages, a stronger solution of the fungicide is necessary.

Plant Diseases.—J. Smolák ‡ has made a contribution towards our knowledge of silver-leaf disease in comparing the cytology of diseased and healthy leaves. In silvered leaves the mesophyll is thicker; the cells of the spongy parenchyma are stimulated to growth in length, and the intercellular spaces are more extensive. The nuclei of the cells tend to become irregular or amœboid, and are gradually disorganized; evidence was also forthcoming of amitotic divisions. The author concludes that the diseased tissue resembles parasitized tissue, somewhat of the nature of gall tissue, and suggests that the changes are due to the secretion of a toxin by the leaves themselves. Bacteria were occasionally found in the tissues.

F. L. Stevens § records a disease of corn in Porto Rico due to an attack of *Phyllachora graminis.* The fungus forms black spots on the leaves and leaf-sheaths, each one representing a stroma in which are produced the perithecia of the fungus.

F. D. Fromme and H. E. Thomas ‖ have reported a destructive root-rot of apple-trees prevalent in the orchards of Virginia, due, apparently, to the conidial stage of a species of *Xylaria.* Two or more species of *Xylaria* are involved, and more study is required. Apparently all varieties of apples are susceptible, and probably equally so.

L. Petri ¶ gives additional notes on the chestnut disease. He finds

* Comptes Rendus, clxiv. (1917) pp. 230–2.
† Ann. Appl. Biol., iii. (1917) pp. 93–6 (1 pl.).
‡ Ann. Appl. Biol., ii. (1915) pp. 138–57. See also Bot. Centralbl., cxxxii. (1916) p. 269.
§ Phytopathology, vii. (1917) pp. 55–6 (1 fig.).
‖ Phytopathology, vii. (1917) p. 77.
¶ Atti Reale Accad. Lincei, cccxiii. (1916) pp. 499–501.

that infection of the fungus causing the disease takes effect at the base of the large root; the mycelium invades the cortical parenchyma after penetrating the thin layer of periderm. After the death of the cambium cells a browning of the whole tissues takes place.

Melusio Turconi * has added three fungi to those already known as living on *Theobroma Cacao*. The host-plant was in cultivation in the botanical garden at Pavia, and it was found to be suffering from some parasitic attack. The disease took the form of lighter-coloured spots on the green leaves; on these spots on the upper surface of the leaves appeared the perithecia of a Pyrenomycete, determined as a new species, *Physalospora Theobromæ*. Associated with the fungus were two conidial forms, *Stachylidium Theobromæ* sp. n., and *Helminthosporium Theobromæ* sp. n. The author does not say if he established any relationship between these different fungi.

A preliminary account † of disease due to species of *Sclerotinia* is now published, later to be issued as a Leaflet No. 271 by the Board of Agriculture. *Sclerotinia sclerotiorum* is a well-known parasite of a large number of cultivated plants, and in certain cases causes very great damage. In potatoes it attacks the stems just above the ground and very soon causes the death of the whole shoot. The mycelium forms small hard black bodies in the interior of the stalks, which remain on the ground after the rotting of the host-tissues and in time produce apothecia and spores which renew the infection. Advice is given to collect and burn all diseased plants, and to avoid planting on infected soil for a space of three years; any kind of plant is liable to be attacked.

Nechleba ‡ has published some observations on the disease of Conifers due to *Armillaria mellea*. It is only sporadic on these trees, and is apt to pass to them in mixed woods; but if Conifers are planted after deciduous trees (hosts of *Armillaria*) the disease may become epidemic—even then it develops only vegetatively. The most dangerous neighbours are beeches and winter oaks.

Gerold Stahel § reports a severe attack of *Cacao* by *Marasmius perniciosus* in Surinam. It grows more especially on the fruit.

James R. Weir ‖ writes of a new leaf- and twig-disease of *Picea Engelmanni*, which he has determined as *Herpotrichia quinqueseptata* sp. n., one of the Pyrenomycetes. The perithecia grow singly or in groups; the ascospores are elongate, septate, and clear brown in colour. In a further communication he describes a new host-plant for *Wallrothiella Arceuthobii*, in Montana and Idaho, on Mistletoe. It has been found also on Mistletoe in the United States. Weir considers that it may be of importance in destroying the Mistletoe.

* Atti Reale Accad. Lincei, cccv. (1917) pp. 75–8.

† Journ. Board Agric., xxiii. (1917) pp. 1095–98 (2 pls.).

‡ Forstwiss. Centralbl., xxxvii. (1915) pp. 384–92. See also Zeitschr. Pflanzenkr., xxvii. (1917) p. 49.

§ Dept. Landb. Surinam, Bull No. 33 (1915) (12 pls.). See also Zeitschr. Pflanzenkr., xxvii. (1917) pp. 49–50.

‖ Journ. Agric. Research, iv. (1915) pp. 251–3 (1 pl.) and 369–78 (3 pls.).

In the same Journal W. O. Gloyen * describes *Ascochyta clematidina*, the cause of stem-rot and leaf-spot of *Clematis*. It spreads from the leaf-stalk to the stem, which it girdles at the nodes, and it finally kills the whole plant. Successful inoculations were made of various stems of *Clematis*, and leaf-spot was induced by sprinkling with the spores.

W. O. Glover † describes a disease of *Clematis* causing rotting of the stems and mottling of the leaves due to *Ascochyta clematidina*. The fungus attacks the leaf, forming blotches on the surface. The mycelium then passes down the petiole as far as the axil and forms a zone of infection which induces the death of the plant tissues above the zone. Artificial cultures of the fungus were made and successfully inoculated on healthy plants. Advice is given as to combating the disease.

W. N. C. Belgrave ‡ describes the fungi that attack the coffee-plant in Malaya. *Hemileia vastatrix* is present, but not abundant; other parasitic fungi attack the *Hemileia*, and probably reduce it considerably. The foliage is further attacked by *Phyllosticta*, *Coniothyrium*, and a species of *Colletotrichum*.

The stems are killed by two fungi, *Diplodia* and *Colletotrichum*, but so far the damage is slight. Among the fungi observed on the fruits are *Pestalozzia Coffeæ*, *Hemileia vastatrix*, and species of *Stilbum*, *Fusarium* *Coniothyrium*, and *Capnodium*, the latter in conjunction with scale insects.

Ascochyta hortorum was found by L. Gabotto § to have attacked artichokes in the neighbourhood of Genoa, in Italy. A number of brown pycnidia were found on the scales and peduncles, and on the insides of the rotting receptacles. Though the same fungus had attacked various economic Solanaceæ it had not previously been found on artichokes.

L. Petri and A. Adani ‖ have investigated a disease of the cones of *Pinus Pinea* due to *Sphæropsis necatrix* sp. n. There are two forms of the disease, "pine gallerone," which appears in May or June, and "pine pagliose," in September and October. The same fungus causes the disease in both instances, but in the spring attacks the cones lose considerably in weight. In both cases there is a discoloration of the scales, exudation of resin, destruction of the endosperm, and the presence of mycelium and pycnidia. In the autumn form, owing to the more mature condition of the cones, the infection proceeds more slowly, the mycelium penetrates between the scales and attacks the soft parenchyma,

* Journ. Agric. Research, iv. (1915) pp. 331–2 (5 pls.). See also Zeitschr. Pflanzenkr., xxvii. (1917) pp. 51–2.

† New York Agric. Exper. Stat., Geneva, Tech. Bull., ii. (1915) p. 3–14 (4 pls.). See also Bull. Agric. Intell. Rome, vii. (1916) pp. 1043–4.

‡ Agric. Bull. Fed. Malay States, iv. No. 4 (1916) pp. 111–13. See also Bull. Agric. Intell. Rome, vii. (1916) p. 1040.

§ Riv. Patolog. Veg., vii. (1916) pp. 45–6. See also Bull. Agric. Intell. Rome, vii. (1916) p. 1041.

‖ Ann. R. Accad. Agric. Torino, lix. (1916) 23 pp. (12 figs.). See also Bull. Agric. Intell. Rome, vii. (1916) pp. 1044–5.

which envelops the seed. From there it spreads through the scale towards the lower surface from which the sporigenic organs emerge.

J. McMurphy * records an attack of oats in California by an unidentified species of *Phytophthora*. The symptoms of the disease were spots and stripes of varying size along the edges, or a long stripe along the central line of the leaf. The parts attacked are yellow, then whitish, finally they become brown and dry up.

Rot of Potato Tubers.†—L. A. Hawkins has investigated the effect of *Fusarium* spp. on potatoes. He found that the crude fibre contents of the tubers were not reduced, starch and methyl pentosans were not affected appreciably, while the content of other substances was reduced. *Fusarium oxysporum* and *F. radicicola* were found to secrete sucrase, maltase, xylanase and diastase.

Disease of Pecaw Catkins.‡—The staminate catkins of pecaw, *Carya illinœnsis*, were discovered by B. B. Higgins to be affected by a parasitic fungus belonging to the genus *Microstroma*, which resulted in the destruction of most of the anthers, or more especially of the pollen-grains. Apparently no toxic substance was secreted by the fungus, since the protoplasts and nuclei of the infected tissues retained nearly their normal appearance. The changes in the cells indicated starvation.

The fungus was determined by the writer to be a new variety—var. *robustum* of *Microstroma Juglandis*. Cultures on artificial media were not very successful, only a yeast-like growth being formed.

Sour Rot of Lemon. §—This is a disease that affects lemons in storage, often causing great loss. The cause has been investigated by Clapton O. Smith. The trouble was especially evident in California in the summer of 1915, the fruit collected in spring suffering most.

A microscopic study of the diseased tissues, along with inoculation experiments, proved the cause of the trouble to be the fungus *Oospora Citri-aurantii*. It is closely allied to *Oospora lactis*, but the latter, though so similar morphologically, differs in its non-pathogenic character. When the latter is inoculated on the lemons a slight mycelial growth arises, but the tissues are uninjured. It was found that *Oospora Citri-aurantii* only attacked fruit through some wound or through spots injured by some other fungus such as *Pythiacystis citrophthora*.

Mycorrhiza of the Marattiaceæ.‖—Frequent references have been made in past years to the presence of a mycorrhizal fungus in the roots

* Science, xliii. (1916) p. 534. See also Bull. Agric. Intell. Rome, vii. (1916) p. 1212.

† Journ. Agric. Research, vi. (1916) pp. 184–96. See also Bot. Gaz., lxiii. (1917) p. 88.

‡ Phytopathology, vii. (1917) pp. 42–5 (2 figs) and pp. 499–501 (2 figs.).

§ Phytopathology, vii. (1917) pp. 37–41 (2 figs.).

‖ Ann. Bot., xxxi. (1917) pp. 77–99 (1 pl. and figs.).

of ferns belonging to the Marattiaceæ, *Angiopteris*, *Kaulfussia*, etc. Cyril West has now made a thorough examination of the roots of *Angiopteris evecta*, *Archangiopteris Henryi*, *Kaulfussia æsculifolia* and *Marattia Cooperi*. In all of them he found a similar type of endophytic fungus. It enters the root through any of the epidermal cells in spite of the cuticularization of the outer wall of these cells; it is both inter- and intra-cellular within the tissues of the host (mostly intercellular in the inner cortical layers), and the filaments show few septa. The secretion of enzymes is probably confined to the tips. From the intercellular hyphæ branches pierce the neighbouring cells and form arbuscules within them, but in time these become disorganized and probably are utilized as food to some extent by the host-cell, which remains healthy. Mycelium is invariably absent from the tannin cells and outside the ring of mucilage canals. Vesicles are formed at the tips of the hyphal branches, which West regards as reserve bodies. In addition spores are formed either intercalary or terminal; they possess a thin smooth exospore and a thick yellow mesopore layer or middle wall, and are three to four times wider than the hyphæ which give rise to them. These spores were frequently found lying free in the tissues of the host, but there was never any evidence of germination, and it is concluded that they do not germinate till they reach the soil by decay of the roots. The lack of suitable living material prevented further examinations by cultures.

West considers that the fungus most nearly approaches the genus *Phytophthora*, and he has named it *Stigeosporium Marattiacearum* g. et sp. n.

He also investigated the mycorrhiza of *Danæa alata* and *D. nodosa* which was distinct from *Stigeosporium*; no reproductive bodies were found. West has discussed the relationship between the host and the fungus. He does not find that the fungus contributes any material from the soil, and evidence is lacking as to the fixing of free nitrogen. The host to a slight extent uses up the disorganized arbuscules.

On the other hand, while the fungus does no damage to the host, it yet lives on the host products as starch invariably disappears from the invaded cells; the resting spores of the fungus with their oily contents are formed at the expense of the higher plant, hence the advantage of the association is almost entirely on the side of the fungus.

Endotrophic Mycorrhiza.*—M. C. Rayner has published a review of recent research on endotrophic mycorrhiza. She gives a short historical sketch of the progress of investigation from the time of Frank onwards. She dwells on the experiments and discoveries by Bernard and Burgeff; the former proved convincingly the obligate character of symbiosis between the orchid seed and the fungus, without which no germination took place. Burgeff confirmed Bernard's work; he suggested the name *Orcheomyces* for these orchid fungi, and he succeeded in growing the fungus of one orchid for twenty-six months on artificial media.

* New Phytologist, xv. (1916) pp. 161–75.

In 1915 Rayner published an account of the obligate symbiosis of *Calluna vulgaris* with a fungus; she isolated it, grew it in pure culture, and found that a fruiting body was formed with some resemblance to a *Phoma*. *Calluna* itself in pure cultures does not develop beyond the seed-leaf stage, and is incapable of forming roots. In this plant the fungus extends through the whole of the plant in an extremely attenuated condition right to the ovaries, so that the seeds are infected with the fungus in the form of delicate hyphæ on the surface of the seed-coat.

Gallaud's views on the physiology of the relationship between the two organisms is discussed at some length, more especially the physiological relationships between the two plants. The work of Kusano on *Gastrodia elata* is also dealt with at length. The writer has adopted Bernard's view of the relationship, viz. "that the phenomenon of mycorrhiza in plants is only an expression of the warfare waged continually by all organisms against parasitic invasion of their tissues. The flowering plant possessing mycorrhiza has done more than hold the invader in check; it has turned the intrusion to its own advantage."

Lichens.

(By A. Lorrain Smith, F.L.S.)

Edible Lichens.*—An instance of the use of lichens as food has been recorded from America by Tom Wilson. The Indians in British Columbia collect *Alectoria jubata*, which they prepare by placing in a heated pit alternate layers of damp grass and of lichens till the pit is full. Hot stones are laid around, and for a day or more the whole mass is kept as hot as possible; it is then ready for consumption. If not well prepared it is apt to mildew, but after a month it was found to be quite good for eating.

New Rare or Critical Lichens.†—W. Watson draws attention to the renewed interest in lichens on account of their dyeing properties. He describes two new species of Pyrenocarpei, *Thelidium tetrestre*, which grew on the soil of a hedge-bank in South Somerset, and *Polyblastia mortensis*, collected on the soil-cap of walls or on mortar, often on decaying mosses, at Morte, North Devon, near the sea. Diagnoses are given, and the characters that differentiate these from related species are noted. A list of somewhat rare lichens with critical notes is appended.

* Ottawa Naturalist, xxx. (1916) pp. 17–21. See also Bryologist, xx. (1917) p. 32.
† Journ. Bot., lv. (1917) pp. 107–11 (figs.).

Mycetozoa.

(By A. Lorrain Smith, F.L.S.)

New Ceratiomyxa.* — Fr. Xavier Skupienski describes the new mycetozoon, *Ceratiomyxa sphærospora*, a minute species scarcely visible to the naked eye, which grew on a piece of decayed wood at Fontainebleau. The size of the unbranched sporophores and the form of the spores differentiate the new species from those already described.

Schizophyta.

Schizomycetes.

Further Note on Bacterial Parasites of the Cockchafer.†—A. Paillott has previously described three new bacterial infections of the common cockchafer (*Melolontha vulgaris*). In the present communication some further notes are given with regard to their pathogenicity.

Diplococcus melolonthæ—This organism takes some two or three days to kill the cockchafer. Its virulence is not increased by passage, and the grubs of *Lymantria dispar* and the silk-worm are very refractory to inoculation, the diplococci being rapidly phagocytosed and have not time to multiply in the organism.

Diplobacillus melolonthæ is more pathogenic for the cockchafer than the diplococcus. Eight insects showed septicæmia after twenty-four hours' inoculation, and one died of infection. The microbe is also slightly pathogenic for the grubs of *Lymantria dispar*. The mortality among inoculated silk-worms was some 30 to 40 p.c.

Bacillus hoplosternus is very pathogenic for the cockchafer. At first passage, death followed in from twenty-four to thirty-six hours; on the second passage in less than twenty-four hours. The caterpillars of *Vanessa* are very sensitive to the action of the bacillus, dying in from twenty to twenty-four hours on the first passage, and from six to seven hours on the second. At this degree of virulence it is capable of killing the larvæ *per os*. After the death of the grub the bacteria rapidly increase in number, and form spores. Inoculation of the grubs of *Lymantria dispar* shows irregular mortality. Some of the larvæ die in twenty-four hours, but others apparently have natural immunity to the infection and survive the experiment. The bacilli found in the blood in these cases are modified, appearing as small, swollen, non-sporing elements.

Atypical Strain of Bacillus Paratyphosus B.‡—R. J. Weissenbach has isolated from the blood of a case of clinical enterica infection an organism presenting the cultural and morphological characters of the

* Bull. Soc. Mycol. France, xxxii. (1916) pp. 37–41 (3 figs.).
† C.R. Soc. Biol. Paris, lxxx. (1917) pp. 56–8.
‡ C.R. Soc. Biol. Paris, lxxx. (1917) pp. 91–4.

paratyphosus group of bacteria. The cultural characters on gelatin, potato and litmus milk class it in the Salmonella group, but the reaction upon metallic salt media (double tartarate of iron and potassium gelatin, nitro-prusside of sodium agar and neutral acetate of lead agar), are those of *B. paratyphosus A*. The agglutination reactions, however, were those of *B. paratyphosus B*. It is thus obvious that no single reaction, or group of reactions, can be depended upon for the complete identification of an organism, but that all available methods of investigation should be applied if sources of error in diagnosis are to be avoided.

Cristispira polydoræ.*—F. Mesnil and M. Caullery have isolated from a sea annelid (*Polydora flava*) a spirochæte organism to which they have given the name "*Cristispira polydoræ*." This microbe is met with in the glandular region of the digestive tube. When the animal is crushed this portion of the intestine is broken, and a yellowish fluid, in which the parasites are found, is extruded. The spirochætes are best stained by the method of Casares-Gil for cilia staining (tannin-ink, chloride of alumina, and basic fuchsin). The parasite possesses a flexible body, some 10 to 25 μ in length. An undulating membrane can be made out, which stains strongly and follows the movements of the body. In this respect it resembles the spirochæte of the crystalline body of lamellibranch molluscs, which also belongs to the same genus. The extremities of the body are slightly pointed, sometimes rounded. Longitudinal division was not observed ; fission, if it occurs, is probably transverse.

Urinary Infection with Pseudo-plague Bacillus.†—C. Elders reports the finding of a member of the Pasteurella group of bacteria in the urine of a patient suffering from pyelocystitis of long standing. Cultures of the organism on agar plates gave smooth lens-shaped colonies with regular edges, greyish-white in colour, and at first quite transparent. They were shiny, viscous, and were capable of being drawn out in threads when touched with the platinum needle. Microscopically the organisms appeared as bi-polar bacilli, Gram-negative and non-motile, measuring 2–3 μ in length by 0·75 μ in breadth. Growth occurred at room temperature on Loeffler's medium, gelatin and agar, the organisms on agar being coccoid in form. Gelatin was not liquefied, and milk was clotted in four days at 37° C. Turbidity with sedimentation and film formation was observed in urine media. In peptone water indol production was demonstrable on the seventh day. Growth on potato was scanty, but the organisms which grew formed long threads some 10 μ in length. Rothberger's neutral agar was not reduced and gas formation was not in evidence. Acid, without gas, was produced in glucose, levulose and galactose. Lactose was fermented slowly, but no change occurred in maltose and sacchrose, nor was hæmolysis present in blood agar. The virus was pathogenic to rabbits, but small doses pro-

* C.R. Soc. Biol. Paris, lxxx. (1917) pp. 1119–21.
† Neder. Tijdschr. v. Geneeskunde, xvi. (1917) pp. 1391–6.

duced anti-sera of high titre; a dilution of 1 to 10,000 being sufficient to agglutinate the organism.

Carbohydrate Fermentations by Bacillus pestis.*—H. W. Wade states that comparison has failed to demonstrate any distinct difference, qualitative or quantitative, between the fermentation activities of Oriental (Philippine) and certain American strains of *B. pestis*. There is, on the other hand, a rather remarkable agreement between the different strains except solely with regard to glycerin fermentation.

Bacillus resembling Bacillus tetani.†—R. S. Adamson and D. W. Cutler make a preliminary communication relative to an organism which morphologically somewhat resembles *B. tetani*. It is, however, larger, and when young exhibits motility. It is a strict anaerobe, forms terminal spores,and is Gram-negative. The colonies on nutrient media differ materially from these of *B. tetani*. It is not pathogenic to laboratory animals.

Mycobacillus synovialis.‡—A. Chantemesse, L. Matruchot, and A. Grimsberg describe an organism which has affinities with the Bacteriaceæ and Fungi. Hence they call it *Mycobacillus synovialis*. It was isolated from the pia mater and from the endocardium. It was easily cultivated on the usual media, and though an aerobe it was also a potential anaerobe. In young cultures it was a motile rodlet, often with a spirillary motion. Flagella were not demonstrable. In older cultures the organism became filamentous and non-motile. Some parts stained by Gram's method, others not. In quite old cultures spores were formed. Pure cultures injected into animals sometimes gave rise to arthritis and endocarditis. If the dose be massive the animals die quickly.

Atypical Actinomyces.§—S. Yamakawa isolated from an abdominal abscess, which was cured by the administration of potassium iodide, an atypical *Actinomyces*. It formed grains but not clubs. The filaments were wavy, showed true branching and also small bulbous terminal swellings. It was cultivated on the usual media, but growth was slow. The microscopical appearances of the cultivated fungus were very variable—wavy filaments, rodlets, branchings, and sometimes terminal swellings. The older filaments were frequently granular and showed Gram-positive knob-like forms. Pure cultivations were not pathogenic to animals, though the original pus was. The author claims that the fungus is a variety of *Actinomyces*, near type *Bacillus Shiotas*.

Abnormal Colonies formed by Yeasts and Bacteria.‖—H. Zikes has found that on gelatin-plate cultures of beer-yeasts some colonies

* Philippine Journ. Sci., xi. Sec. B (1916) pp. 159–82.
† Lancet, May 8, 1917, pp. 688–9.
‡ Comptes Rendus, clxiv. (1917) pp. 652–5.
§ Mitt. Kaiserl. Univ. Tokio, xvi. (1916) pp. 17–31 (14 figs.).
‖ Centralbl. Bakt., xlvi. 2te Abt. (1916) pp. 1–4, through Journ. Inst. Brewing, xxiii. (1917) pp. 210–1.

are often observed which grow upwards into the air, forming a kind of stem of much greater length than thickness. These finger-like colonies are formed in greater number by some yeasts than by others, but their formation depends chiefly on the stiffness of the gelatin and the proximity of the original cell to the surface. When the gelatin is stiff, especially if the surface dries fairly rapidly, the newly-formed cells appear to be unable to displace it, and, in consequence, they grow upwards. After a time, however, probably when the surrounding gelatin has become sufficiently exhausted to be more yielding, the base of the outgrowing colony begins to spread laterally in the medium. Before this stage the colony can be lifted out of the gelatin, leaving only a few cells adhering to the latter. The author observed certain differences between the cells in different parts of such colonies. The outer cells of the basal part are elongated, whilst the central ones and those of the upper end are round or oval. The elongated cells contain more vacuoles, and are richer in glycogen than the others. If one side of such an outgrowing colony is illuminated by a lamp, the colony bends over towards that side, owing to the more rapid growth of cells on the unilluminated side.

MICROSCOPY.

A. Instruments, Accessories, etc.*

(3) Illuminating and other Apparatus.

Sedgwick-Rafter Ocular Micrometer.†—C. E. Turner, who describes this micrometer, states that it is sub-divided, and when used with an ocular of the No. 4x Spencer type (2-inch) and a 16-mm. objective can be so standardized by the aid of a stage micrometer that the large square will outline a square millimetre surface. The smallest square will then be 20 micra on a side, and the micrometer will form a convenient measure for larger microscopic objects. By only a slight change in the tube length a standardization with the 4-mm. objective can be made, which will increase the magnification five-fold, thereby reducing the side of the large square to 200 micra, and that of the smallest square to four, so that with the high power the dimensions of all but the very smallest microscopical organisms can be readily obtained. There is also a marked advantage in the way it is ruled into squares of various sizes. It enables one to measure the length and the breadth of an object at the same time, and yet leaves the greater part of the field of vision relatively free from lines interfering with clear definition of objects. Ocular micrometers may be made by engraving or photography. In either case the actual size of the large square ruled on the glass should be 7 mm. on a side. The advantages of this type of micrometer are its ready adaptability to general use with high or low powers of the microscope ; the definition of measured squares or unit surfaces which are easier to use and to fix in mind than are linear units ; a comparatively unobstructed field, and in the photographic product, low cost.

Polarized Light for Detecting Foreign Bodies in Wounds.‡—A. Policard and B. Desplas, who had noted the great frequency of microscopic foreign bodies (fragments of clothes, particles of wood, &c.) in healthy wounds, particles invisible to the naked eye and very difficult to make out in sections when placed under the microscope, find that these foreign bodies are easily located under polarized light. All such foreign bodies are birefringent. When the Nicols are crossed they

* This subdivision contains (1) Stands; (2) Eye-pieces and Objectives; (3) Illuminating and other Apparatus; (4) Photomicrography; (5) Microscopical Optics and Manipulation; (6) Miscellaneous.

† Trans. Amer. Micr. Soc., xxxv. (1916) pp. 186-8 (1 fig.).

‡ C.R. Soc. Biol. Paris, lxxx. (1917) pp. 248-9.

shine up on a dark background. By slowly uncrossing the Nicols they are easily located in the section.

Polariscope.*—E. M. Nelson states that :—"It is not generally known that diatoms are polariscope objects, for it is understood that silex will not polarize, so probably diatomists, accepting that statement, have not further troubled themselves about the matter ; at least, that is what I have myself done, and thought that, with the exception of a *Pleurosigma balticum*, few diatoms were suitable objects for a polariscope. This, however, is quite a mistake, for the other day I observed that diatoms with thick silex, such as *Coscinodisci*, *Aulacodisci*, the polygonal structure of the larger *Triceratia*, the thick radiating bars of *Arachnoidisci*, the edges of *Navicula lyra*, &c., exhibited polarizing effects strongly. These diatoms were all mounted dry on cover. The very thick diatom *Eupodiscus argus* shows these effects even in a balsam mount. An *Auliscus oamaruensis* Gr. and S., when illuminated on a dark ground with a condenser and stop, $\frac{1}{3}$ objective of 5 N.A., with polarized light (blue), gave one of the most charming images of a diatom I have ever seen. Polycistines, which are also silicious, showed no trace of any polarizing effect. Polycistines are animals, and it may be that silex deposited by animals does not exhibit polariscope effects, while that deposited by plants, such as diatoms, will do so. Foraminifera are mostly lime, and show splendid colours under polarized light. It is surprising that they are not more often examined that way, as it might be of assistance in determining species. *Globigerinæ* show the black cross plainly. As few microscopists, who are not mineralogists, understand how to work with polarized light to the best advantage with an ordinary microscope, and as no help is given in any of the text-books, the following notes may be of assistance. Set up the microscope with substage condenser in the ordinary way. Place the polarizer below the substage, and the analyzer above the eyepiece. Rotate the analyzer until the field becomes dark, and note its position for a fiducial point. Rotate the analyzer to 90° on either side of this, and place a $\frac{3}{4}$ wave-plate selenite in the stop-holder below the condenser, and rotate it until a fine background is obtained. Note :—If the selenite is placed in a rotary holder above the substage condenser a smaller one would do. This forms the best polarized field upon which to view objects. As a Nicol is now an expensive luxury, an excellent polarizer can be made by placing eleven disks of extra thin slip glass, each having three little spots of thick notepaper gummed to its periphery, to keep the glasses from contact. Below the last piece of glass a piece of black (needle) paper should be placed. These glasses should be kept quite clean, the mirror cell should have a screw ring, so that they may be easily removed. As a concave mirror is never used, they may quite well take its place. The cost of this mirror cell and the eleven glasses would be a trifle, compared with that of a large Nicol. To set the mirror in the correct position, cut an angle of 114° out of a postcard, bisect this angle by a line ; place the angle on the mirror with one arm of the angle pointing up the optic axis of the microscope, then the other arm will point to where the light ought to

* English Mechanic, cv. (1917) p. 184.

be: the mirror must be turned so that its surface is at right angles to the bisecting line. All this takes a little trouble at first, but after it has been set up once or twice, it does not take thirty seconds to place the separate parts in their proper positions. The results obtained from this polarizer are, apart from special optical test, practically indistinguishable from those derived from a large Nicol, which would cost more than the whole microscope and its outfit! For example, with a $1\frac{1}{2}$-inch objective and a $\frac{3}{4}$-cone from Quekett condenser, A eyepiece, and a granite section on stage, flat of flame of paraffin lamp being the illuminant, the image was perhaps too bright for the eye when the analyzer was rotated so as to give a dark field; this shows how satisfactory a cheap polarizer can be. Fifty years ago black glass was used, but it gives very poor results; there was, however, another form of polarizer used about that time. It was made of a pile of twenty cover-glasses placed obliquely at an angle of 33° in the substage. When light is transmitted through a pile of plates so placed it will be polarized, but the direction will be at right angles to that produced by reflexion; this means that an analyzer, to obtain a dark field, must be rotated through an angle of 90° from its former position. I have never seen one of these polarizers fitted to a microscope, but I am going to try it when opportunity occurs.

"The apparatus, therefore, required for these polarizing experiments, beyond that found in an ordinary microscope outfit, is a Glan-Thompson prism to fit over the eyepiece, a selenite $\frac{3}{4}$ wave-plate, and a pile of eleven plates, which takes the place of the concave mirror, as a concave mirror is seldom, if ever, wanted."

C. T. Whitmell* writes as follows:—"Having had a good deal of experience with this subject, I send a few notes supplementary to Mr. Nelson's interesting letter. For the polarizing reflector he recommends about a dozen disks of thin glass kept from contact by little spots of paper. But it is quite unnecessary to separate them. It is a disadvantage, for dust will get in. The disks should be in contact, and, to guard against dust, it is as well to fasten a strip of paper round the edges, taking care that none of the adhesive used is drawn in between the disks. These are really separated by thin layers of air; they are not optically in contact. For a transmission polarizer he recommends a pile of twenty glass slips placed so that the light makes an angle of 33° with the surfaces. But better results will be obtained, and with less trouble, by using, say, half this number, and arranging for the rays to pass at a smaller angle with the surfaces. It is quite remarkable how considerably light may be polarized by transmission through even a single glass plate if the incidence is nearly grazing. By a rough calculation, about 60 p.c. of the light, transmitted through a single glass plate, is polarized perpendicular to the plane of incidence, when the ray makes an angle of 1° with the surface. When the angle is 33°, an infinite number of plates will be required to produce complete polarization. Both examples are inconvenient in practice. I should advise about ten slips, and make the angle as small as convenient. The polarization by transmission is never perfect, as it is by reflexion. In order that the

* English Mechanic, cv. (1917) p. 198.

polarization by reflexion should be complete, the tangent of the angle of incidence, measured from the normal to the surface, should equal the refractive index of the glass used. When this is 3/2, the angle is 56° 19′. (See letter 212, p. 188.) I see that Mr. Nelson uses 57°, which is nearly the same. The selenite is not necessary, but adds much to the beauty of the slides."

B. Technique.*

(1) Collecting Objects, including Culture Processes.

Preparation of Culture-media containing Albuminous Fluids.† P. Fildes gives the following technique for the sterilization and preparation of albuminous culture-media :—

Sterilization of Serum.—The serum should be collected at the slaughter-house, horse serum being used on account of the rapidity with which the corpuscles deposit. When horse serum is not available ox serum may be used. The serum is collected as free as possible from corpuscles and allowed to stand in the ice-chest in tall sterile jars about 2 in. in diameter. At the end of about five days the corpuscles will be about half deposited. The separated serum is now distributed in measured quantities (200 c.cm.) into perfectly fitting glass-stoppered bottles, or into large glass bottles. Chloroform is added to each bottle to make 0·5 p.c. A drop of sterile oil is then applied to the stopper to prevent sticking, and a dust-cover is fastened tightly over it. The bottles are placed in the water bath at 45° C. for one hour, being shaken occasionally. When they have cooled, a sample may be removed and mixed with agar to test sterility (five days' test). When the serum is required for any purpose entirely unaffected by heat, sterility may be obtained by placing the bottles in the air incubator at 37° C., and shaking occasionally. After twenty-four hours they will in most cases be found to be sterile. When sterilized the serum is stored in a cupboard. When required as a medium, the chloroform can be removed by pipetting the serum off in measured quantities (50 c.cm.) into 200 c.cm. flasks, and then heating to 55° C. and placing under the receiver of a pump. When a partial vacuum has been obtained, the receiver containing the flasks is shaken and the chloroform then boils off. The serum is now ready to incorporate in culture-media.

Sterilization of Ascitic Fluid.—The ascitic fluid is collected from the patient into a large glass bottle and allowed to stand in the ice chest for a couple of days. The fluid is then decanted or filtered through glass wool. The reaction is made slightly alkaline, or neutral with acid or

* This subdivision contains (1) Collecting Objects, including Culture Processes; (2) Preparing Objects; (3) Cutting, including Embedding and Microtomes; (4) Staining and Injecting; (5) Mounting, including slides, preservative fluids, etc.; (6) Miscellaneous.

† The Lancet, cxcii. (1917) pp. 492-3.

alkali. The fluid is then distributed into stoppered bottles and chloroformed and treated as above.

Sterilization of Blood.—The blood, collected at the slaughter-house, is defibrinated by stirring with a large wooden stick wrapped in gauze, the whole being previously sterilized. In order to sterilize the blood by the heat-chloroform method it is necessary to lake it before adding the chloroform. For this purpose an equal part of distilled water is added to the blood, and the mixture distributed as in the case of serum, 9·5 p.c. chloroform is then added, and the bottles are well shaken. The bottles are placed in the air incubator at 37° C. and shaken constantly. After twenty-four hours a sample is taken to test for sterility, and pending the result the bottles are not returned to the incubator, because the longer blood is heated the darker the colour becomes. Twenty-four hours is invariably long enough to ensure sterility. If subsequently mixed with agar care must be taken that it is not heated above 55° C., and for as short a time as possible.

Method of Preparing Media with Sterile Albuminous Fluids.—1. Ascitic agar—ordinary lemco- (or meat-) pepton agar is prepared containing 2½–3 p.c. agar. It is measured into 200 c.cm. flasks in quantities of 150 c.cm. and autoclaved. When required for use a flask of agar is melted and treated in one of two ways: (*a*) It is poured into a sterile distributer, maintained in a water bath at 59° C., and a flask of ascitic fluid (50 c.cm.) is added. The contents are mixed and then tubed through a hooded pipette. (*b*) The flask of ascitic fluid may be poured directly into the melted agar in its flask and mixed, and then rapidly poured into Petri dishes or tubes. The agar should be mixed with the ascitic fluid at a temperature as low as possible. This medium is admirable for primary throat cultures of the meningococcus. 2. Serum agar. This medium is prepared in exactly the same way as ascitic agar, using serum. Meningococci sometimes fail to grow on this medium. 3. Blood agar. An excellent transparent blood agar may be prepared by adding 25 p.c. of sterile laked blood to 2½–3 p.c. agar. The finished medium thus contains 12·5 p.c. of blood. 4. Blood serum agar. This is the medium the author uses for all routine work with the meningococcus, except the primary cultures from the throat. It contains a small but sufficient quantity of laked blood. He uses one part of blood in 400 of medium, 1 c.cm. of the laked blood (diluted 1 in 2) being added to each 50 c.cm. flask of the serum, or the blood may be added in bulk to the bottle of serum before this is distributed into flasks. In order to reduce the colour, neither lemco nor meat is used in the preparation of the agar; merely salt solution and pepton (Morson's). The growth of the meningococcus on this medium is profuse. Other delicate pathogenic organisms, such as the pneumococcus and streptococci, also develop abnormally large colonies upon it.

War Media—Snail Bouillon.*—P. Remlinger states that various varieties of snails ("abundant in certain gardens to the point of constituting a regular plague"!) can furnish a nutrient broth capable of being used for most bacteriological purposes. It is prepared in the

* C.R. Soc. Biol. Paris, lxxx. (1917) pp. 1109–10.

following simple manner :—Weigh out 800 to 1000 grms. of snails, and boil slowly for a half to three-quarters of an hour in one litre of water. The body of the animal can then be easily extracted from the shell. Filter by squeezing through a cloth. Add ten grms. of pepton and five grms. of salt. The liquid is naturally neutral, or slightly alkaline, so that it is unnecessary to alkalinize. Sterilize in the autoclave. Filter cold and re-sterilize. The bouillon is transparent, and of a slightly brownish-yellow colour, and can be incorporated with gelatin or agar in the usual way. By reason of its smaller albuminoid content this media is slightly inferior to those having a beef basis, but is, nevertheless, clearly superior to the media prepared with pepton alone. In the actual conditions of practical bacteriology in the field it is undoubtedly economical, and is suitable for all ordinary laboratory use.

Vegetable Broth as a Culture Medium.*—A. Berthelot states that the following medium has given good results in his hands. The formula and mode of preparation is as follows :—Water, four litres ; potatoes, 300 grms. ; carrots, 150 grms. ; turnips, 150 grms. Peel the potatoes (" Holland or de Vitlette," for preference) and divide them in two ; wash the carrots and turnips, and cut them in slices of about 1 c.cm. thick. Place the vegetables in a marmite of enamelled iron containing four litres of cold water. Boil for four hours, and filter through a fine cloth. The quantity of liquid should be reduced to three litres by the boiling process. If the concentration has gone too far, add a sufficiency of distilled water to make the volume up to three litres. Made feebly alkaline to litmus with $\frac{1}{10}$ soda solution, autoclave at 120°C. for half an hour, leave in the ice-chamber for twenty-four hours, and then filter through filter-paper. Sterilize afresh for twenty minutes at 115°C. The resulting liquid should be limpid, and of about the same colour as ordinary meat-broth. A large number of bacterial species, saprophytic and pathogenic, grow more or less abundantly in this medium. For growth of yeasts and bacteria that cannot multiply in alkaline media, the broth should be left at its original reaction, which is generally feebly acid to litmus. It is stated that pathogenic organisms grown on this media have a minimum of toxicity, and are thus eminently suitable for the preparation of vaccines.

Culture of Spirochæta ictero-hæmorrhagica.†—L. Martin A. Pettit, and A. Vaudremer find that the media which give the best cultural results with *Spirochæta ictero-hæmorrhagica* are as follows:—1. " Sérum de bœuf-eau physiologique." Dilute 1 c.cm. ox serum heated to 50° C., in 9 c.cm. salt solution (0·89 p.c.). Inoculate with heart blood or liver pulp, and cover with vaseline. Incubate between 23° and 33° C. The maximum growth of spirochætes occurs towards the tenth day. Growth ceases in about three weeks. 2. " Sérum de lapin-eau physiologique." Dilute 1 c.cm. rabbit serum in 5 c.cm. salt solution (0·89 p.c.) and proceed as above. The first cultures develop

* C.R. Soc. Biol. Paris, lxxx. (1917) pp. 131–2.
† C.R. Soc. Biol. Paris, lxxx. (1917) pp. 197–200.

best between 23° and 25° C. After the second sub-culture full growth takes place in from four to six days. The sixteenth generation in sub-culture retains full virulence. 3. "Liquide de Locke et sérum de bœuf." Dilute 1 c.cm. ox serum, heated to 56° C., with 9 c.cm. Locke's fluid. Incubate at 35° C., after inoculation. After six days, sixty to seventy spirochætes may be counted in each microscopic field. [The thickness of the preparation is not stated.] Sub-cultures in this medium grow badly, but it is an excellent one for conserving original cultures from infected liver *in vitro*. Spirochætes cultivated by these methods resemble morphologically those found in the liver of the experimental guinea-pig. They are pathogenic for this animal, and stain well by the methods usually employed for the exhibition of cilia (e.g. Loeffler's and van Ermenghen's stains and Fontana-Tribondeau and Ravaut-Ponselle silver impregnation methods).

(3) Cutting, including Embedding and Microtomes.

Preparation of Rock Sections for the Microscope.*—C. H. Caffyn gives the following description of his method of making rock sections for the microscope:—"The preparation of a rock section is not so difficult a task as is generally supposed, and I propose to describe the machine I use and the manner in which I carry out the work. The machine is a home-made one, and consists essentially of a disk for slitting pieces from the hand specimen and a lap for grinding. It can be made by anyone who can use ordinary tools, and the total cost will be well under twenty shillings. It will be seen from the illustration (fig. 2) that the driving part of the machine is an old sewing-machine table, and as the fly-wheel is rather light I have weighted it with lead pipe. After inspection of various rock-cutting machines, I think it is better to have the slitting-disk vertical rather than horizontal, as it is then possible to put larger hand specimens in the holder. The slitting disk is attached to a polisher's lathe-head, to be procured at any tool-shop, and is fitted on to the attachment for holding the circular-saw. The disks are of soft iron 6 in. in diameter, and about $\frac{1}{50}$ in. thick. They must be quite true, without buckle, or will not run well. The rock-holder is a little complicated, but not difficult to make. It consists of a wooden upright carrying a spindle, which in turn carries the holder. The spindle is threaded 16 to the inch, so that one complete turn pushes the rock forward over the edge of the disk ready for a second cut. The holder consists of a piece of wood swinging on the end of the spindle, to which it is attached by the ball-bearings from a bicycle pedal, which allows free movement. Another piece of wood is screwed to this to make one portion of the actual jaws, and the other piece is movable and is clamped down on the rock by two screws with winged nuts. A chain and weight keep the rock against the edge of the disk. The grinding-lap revolves horizontally, and is 8 in. in diameter and $\frac{1}{2}$ in. thick. I use cast-iron for these laps, but they can be made of lead or copper if

* Journ. Photomicro. Soc., vi. (1917) p. 6–10 (2 figs.).

desired. The drive for the lap is taken over jockey pulleys in order to get it horizontal. Mud-guards are fitted to both the lap and the disk, but these are not shown in the illustration. In the actual preparation of the rock a slice is cut from the specimen with the disk, generally about $\frac{1}{20}$ in. thick. This is then smoothed down on the lap to remove the rough saw-cut marks, and is then ground down on a plate of glass with suitable abrasive. I use carborundum No. 150 grit, which I find quite suitable. The rock is rubbed with a circular motion with short sweeps until a perfect plane surface is obtained. It is then rubbed on

Fig. 2.

another piece of glass with FF carborundum till the scratches are removed, and is then polished off on a piece of No. 0 emery cloth. A high polish is not necessary, as long as there are no scratches. The specimen is then mounted on a piece of plate-glass about $1\frac{1}{2}$ in. square to act as a handle for the final grinding. Hard Canada balsam is generally used for this, but I use ordinary gum arabic in a rather thick solution, which I find answers the purpose for all except very friable rocks. When the rock is firmly affixed to the holder, it is ground down on the lap. It is difficult to give any particulars as to the time to be spent on this rough grinding, as it depends on the rock. I usually stop, however, as soon as the edges begin to crumble away, as a few extra turns will take the specimen entirely off the glass. When it is judged thin enough, it is finished off on the glass plate with the fine carborundum, and polished on the No. 0 emery cloth. It is advisable to examine the section under the microscope at this stage to see if it is thin enough, using the polariscope with Nicol prisms crossed. The felspars should then show a grey colour, and the quartz should show no colour above pale yellow. You may not be able to get these colours at first, but do not worry. It is better to leave the section somewhat thick and have a slide of some sort, rather than to try to get it thinner and spoil it. Making good sections is only a matter of practice. After the section is thin enough it is removed from the glass by soaking in methylated spirit if it is cemented with balsam, or in water if cemented with gum. It is then mounted in balsam and benzol in the usual way. Be sure to label the bits of rock carefully during the whole of the operations, or you will find sooner or later that your specimens are hopelessly mixed."

(4) Staining and Injecting.

Microscopic Staining with Copying-ink Pencil.*—At a recent meeting of the Zurich Medical Society, Louis E. Merian called attention to the convenience of using coloured pencils in staining microscopical preparations. The idea was suggested to him by a paper of E. Friedberger in the Military Supplement of the "Münch. med. Wochenschr." of Nov. 21 last. Friedberger has invented a universal pencil for staining pus and blood films as well as gonococci, trypanosomes, spirochætes, and malaria parasites, and he proposes to bring out a Giemsa and a carbol-fuchin pencil after the war. The method of staining suggested was very simple. After fixing, a drop or two of water was placed on the slide, and the coloured pencil rubbed in the water until the required depth of colour was attained. The preparation was then rinsed and dried in the usual way. It occurred to Merian that the ordinary indelible pencil obtainable for 1*d.* (they now cost 4*d.*) might serve the same purpose. The result proved satisfactory for white and red blood corpuscles, gonococci, and spirochætes. Of the various makes of indelible pencil obtainable in Switzerland Merian found "A. W. Faber Radium 5800" the most suitable, while Faber's "Castell," Hardmuth's "Mephisto 73 B. middle," and Rehbach's "Defregger" were also good. Merian claims a special handiness and cleanliness for this method as well as the convenience of carrying the pencil anywhere in the pocket. The stain keeps indefinitely and does not deteriorate as stains do in solution. We have used this method in emergency, finding it to work well for pus, blood and cultures. The drop of water should be placed by the side of the film, the indelible pencil rubbed well into it, and the coloured drop then led over the preparation.

Improved Technique for Showing Details of Dividing Cells.†—Allen offers some suggestions for demonstrating the details of mitosis

* Lancet, May 12, 1917, p. 744.
† Anat. Rec., July, 1916, through Trans. Amer. Micr. Soc., xxxv. (1916) pp. 192–3.

in the central nervous system and in the testes of the rat without producing distortion of adjacent tissues. The addition of a low percentage of urea to fixing fluids results in sharpening the chromosomes and preserving the structure of the achromatic nuclear material. It may help the penetration of fluids. Picro-formol-acetic solutions are more effective when used at about 38° C. Cold is detrimental. Flemming's fluid is more effective if used at 0° C., or even lower. Flemming's fluid is of no value as a brain fixative at any temperature. At times (if urea is added) it isolates metaphase and anaphase chromosomes in spermatocytes somewhat better than any other fixative tried, except B 15, of which the following is the formula: Picric acid, 75 c.cm.; formol, 25 c.cm.; acetic acid, 5 c.cm.: chromic acid, 1·5 grms.; urea, 2 grms. Anilin oil is an excellent substitute for the higher alcohol. Xylol shrinks tissues more than the vegetable oils.

Stains for Microscopical Purposes derived from Methylen-blue.*
L. Tribondeau and J. Dubreuil give the following procedure to obtain the azur and the violet from methylen-blue:—To a 1 p.c. solution of medicinal methylen-blue are added 5–10 p.c. of liquid ammonia. The mixture is placed in a flask and heated in a water-bath to boiling. A copious precipitate forms; this is filtered off while hot. The filtrate, placed in a large photographic dish, is evaporated in an incubator at 37°–40°. The residue consists of methylen-violet practically pure. Some of the precipitate is gathered from the filter, but most is found adhering to the wall of the flask. This is left, the flask not being stoppered, in an ice-box for at least twenty-four hours. When the precipitate has turned to a dark blue it is dissolved in distilled water. It is then filtered and treated as the former filtrate. The powder so obtained is the azur. The quantities of the azur and violet are about equal. From these powders the authors make three staining solutions: (1) An aqueous solution of azur; (2) an aqueous solution of azur and of violet, this they call polychrome blue; (3) an alcoholic-glycerinated solution of azur and eosin, which they call azéo. (1) is a 1 p.c. solution in distilled water; (2) is a 1 p.c. solution of azur and violet, mixed in the proportion of 1–3 by volume; (3) is a mixture of azur and eosin; both are 1 p.c. solutions in alcohol and glycerin (75 alc, 25 glycerin). Mixing them in about equal parts they are left for several days, and then an excess of the alcohol-glycerin solution of azur is added, roughly about 2 parts to 8.

Detecting Protozoal Cysts in Fæces by means of Wet-stained Preparations.†—R. Donaldson's method consists in using a mixture of equal parts of two stains used in any of the three following combinations:—1. 5 p.c. aqueous solution of K1, saturated with iodine, to which is added an equal volume of either—2. (1) Saturated aqueous solution of Rubin S; or (2) saturated aqueous solution of eosin; or (3) Stephens' scarlet writing fluid. A few loopfuls of one of the above stain

* Comptes Rendus, clxiv. (1917) pp. 551–3.
† Lancet, cxcii. (1917) pp. 571–3.

combinations are placed on a slide, a loopful of fæces is rubbed up with the stain, and a cover-glass imposed. The cysts stand out as yellow or greenish-yellow spheres.

Staining Films for Spirochætes and Treponemata.*—M. Favre and N. Fiessinger state that if searching for *Spirochæta ictero-hæmorrhagica* in urine, this should first be centrifuged, and then smears made from the sediment. In other cases, thin smears can be made from pus or blood. Dry the preparations, and cover with the following solution :—Formalin, 2 c.cm.; acetic acid, 1 c.cm.; and water, 100 c.cm. Leave for five minutes. Wash in 95 p.c. alcohol, or absolute alcohol, and apply the following mordant :—Tannin in alcohol, 4 grm., and distilled water, 100 grm. Steam and set aside for thirty seconds. Wash in tap-water, and rinse in distilled water. Cover films with silver nitrate solution to which a couple of drops of ammonium hydrate has been added. (If 5 p.c. solution of silver nitrate has added to it, drop by drop from a fine pipette, a small quantity of silver nitrate, at first a brownish precipitate forms, which clears on addition of more ammonia. This is the proper point at which to stop.) This should be warmed up as in the case of the mordant solution, and left in for thirty seconds. Wash with distilled water, and dry with filter-paper.

(5) Mounting, including Slides, Preservative Fluids, etc.

Cellophane as Substitute for Glass and Mica Lamellæ.†—E. Landau suggests the employment of cellophane as a substitute for glass and mica lamellæ in microscopic sections. The preparation in question is pure cellulose, prepared from wood-pulp, treated with a special glycerin. It is placed on the market in leaves of different thicknesses, and resembles gelatin in appearance. It is insoluble in water, and is unaltered by the action of air, alcohol, chloroform, and xylol, being only attacked by acids and concentrated alkalies. The chief advantage of this material lies in its small cost.

* Bull. et Mémoires Soc. Med. Hosp. Paris, xxxii. (1916) pp. 2070–3.
† C.R. Soc. Biol. Paris, lxxx. (1917) pp. 156–7.

Metallography, etc.

Notes on Pearlite.*—H. M. Howe and A. G. Levy have made a detailed study of the effects of different conditions of cooling from temperatures of 800° and 900° C. on the microstructure and mechanical properties, and on the position and length of the Ar 1 change point, of a eutectoid steel containing 0·92 p.c. carbon.

The sequence and genesis of different microstructures and the exact conditions of cooling favouring their development are set forth. Two additional stages in the series of microstructures representing the transition from sorbite to lamellar pearlite, termed sorbitic pearlite and sub-lamellar pearlite, are described and illustrated. Sorbite is considered to be the first stage in which the transformation is complete, and to consist of an irresoluble mixture of ferrite and cementite; sorbitic pearlite is the next stage in which the ferrite and cementite have sufficiently segregated to cause distinct lighter and darker microscopic masses; sub-lamellar pearlite occurs when the segregation has proceeded a stage further so as to give strong suggestions of lamellarity yet without showing distinct lamellæ. Lamellar pearlite in specimens cooled from 900° C. is coarser than in those cooled from 800° C., and shows much smaller tendency to break up into granular pearlite. The microstructures obtained are correlated with the results of the mechanical tests to show the great deterioration of strength which accompanies granulation of the pearlite. The temperature of the Ar 1 transformation is progressively lowered as the rate of cooling increases, the lowering for certain rates of cooling amounting to as much as 100° below the equilibrium temperature of transformation. Raising the initial temperature of heating has also a slight lowering effect on the temperature of Ar 1. The explanation of these observations is associated with undercooling phenomena. The rate of cooling which is just sufficient to inhibit the Ar 1 change appears to be intermediate between that obtained by an air-blast cooling and that obtained by quenching in molten lead.

Formation of Nickel Steel Scale.†—The reason for the strong adherence of the scale formed by heating nickel steel to high temperatures for any length of time is explained by J. E. Stead, by the interpenetration of metal and oxide at the junction between scale and metal, which arises through preferential oxidation of the iron. Use is made of Stead's cupric re-agent, which does not deposit copper so readily on alloys rich in nickel. Photomicrographs of cross-sections through

* Journ. Iron and Steel Inst., xciv. (1916, 2) pp. 210–32 (7 figs.).
* Journ. Iron and Steel Inst., xciv. (1916, 2) pp. 243–5 (4 figs.).

scale and metal after polishing only, and after etching with the cupric re-agent, show that oxidation follows the boundaries of the crystal grains, and that the residual metal in these grains is enriched in nickel.

Effect of Cuprous Oxide on the Development of Re-crystallized Grain by Annealing Cold-worked Copper.*—C. H. Mathewson and G. V. Caesar have investigated this subject by annealing for one hour at temperatures of 700°, 775°, 850°, and 925°, a series of copper-oxygen alloys, ranging from pure oxygen-free copper to a hypereutectic alloy containing 0·44 p.c. oxygen, all of which had been previously cold-worked by rolling. Photomicrographs were then prepared of each sample after cold-working and after each annealing. These show that the growth of the re-crystallized grains on annealing is progressively retarded as the oxygen content increases, e.g. the number of grains per unit of surface after annealing for one hour at 925° was four times as great in pure copper as in an alloy containing as little as 0·05 p.c. oxygen. The effect is considered to be due to the cuprous oxide imposing a mechanical obstruction to the coalescence of the grains. In alloys of higher oxygen content the grain-growth was noted to be particularly retarded in the eutectic areas. The pure copper was etched with strong ammonia containing a little hydrogen peroxide. For etching the copper-oxygen alloys, the best results were obtained by alternate application of ammonia and hydrogen peroxide and dilute acid ferric chloride. Only slight differences in the hardness of annealed specimens of the same composition were found, despite the large differences in grain-size.

Heat Treatment of Large Steel Forgings.†—The difficulties attendant upon the heat treatment of large masses of steel as compared with small ones are described by Sir W. Beardmore. These include the variations in the rates of heating and cooling which operate throughout large masses, and the distortion caused on quenching by the very considerable internal stresses set up. Structural differences, with corresponding differences in mechanical properties, arise owing to the differencs in rate of cooling from the outside to the centre of large forgings. Hastening the cooling—e.g. by oil-quenching—tends to greater uniformity of cooling rate, but this also fails when a certain limiting size is exceeded. A comparison is given of the microstructure and mechanical properties of the outside and centre of an oil-hardened steel shaft 18 in. in diameter in illustration. In heating large forgings of varying cross-section the parts of smaller cross-section, which attain the furnace temperature long before the parts of larger cross-section, may become coarse in grain-size and consequently weak and brittle, unless special precautions are taken to enable the whole forging to attain the desired temperature simultaneously.

* Inst. Zeitschr. Metallographie, ix. (1916) pp. 1–20 (24 figs.).
† Journ. Inst. Mech. Eng., 1917, pp. 215–24 (4 figs.).

Heat Treatment of Steel Forgings.*—H. H. Ashdown gives a general description, accompanied by numerous illustrations and photo-micrographs, of the heat treatment of steel in works' practice. The importance of pyrometric and metallographic control in ensuring successful results are emphasized: without such control the best steel produced may be hopelessly spoiled.

* Journ. Inst. Mech. Eng., 1917, pp. 225–35 (14 figs.).

PROCEEDINGS OF THE SOCIETY.

AN ORDINARY MEETING

OF THE SOCIETY WAS HELD AT NO. 20 HANOVER SQUARE, W., ON WEDNESDAY, APRIL 18TH, 1917, MR. E. HERON-ALLEN, F.L.S. F.G.S, ETC., PRESIDENT, IN THE CHAIR.

The Minutes of the preceding Meeting, having been circulated, were taken as read, confirmed, and signed by the President.

Mr. Frank W. Lacy was elected a Fellow, by ballot, and the following three nominations were announced: Mr. Ernest Atkinson, Mr. Charles Llewellyn H. Tripp, and Dr. Alfred B. Hitchins.

The President said the Society had to thank Mr. William Beattie for contributing to the Cabinet six mounts of sewage organisms from an open-top cesspool. Also an extremely fine publication, namely, the second Geological Report of the British Antarctic Expedition, that of Sir Ernest Shackleton, which had been presented by the publishers. He was sure it would be the pleasure of those present to return the thanks of the Society to the donors of those contributions.

Thanks were accorded by acclamation.

Mr. D. J. Scourfield said he thought the exhibit he was making of *Sphærœca* ***volvox*** might interest some of the Fellows. It was something like a very small Volvox, but it was not green. The little organisms forming the colony were true animals, and belonged to the class Choanoflagellata, which were sometimes called "collared monads." It was particularly interesting, because one saw here an association of these collared monads on the surface of a sphere very similar to those which occurred inside the more or less spherical chambers in sponges. The drawings on the blackboard represented a colony, with about a hundred individuals, and a single individual showing the collar. When looking at the object under the Microscope the collars are very difficult to see in their entirety. The edges could be perceived, but to see the rim of the little hyaline collar or vase, from the bottom of which the flagellum started, was a very fine test of microscopic work. He hoped that those who had not yet seen this particular form would take the opportunity now; he had not himself seen it at any of the Society's Meetings, and, although probably not very rare, was not mentioned in Kent's "Manual of the Infusoria," having been first described in 1899 by Lauterborn.

Mr. E. J. Sheppard exhibited slides showing ovo-testis in the frog, and the extrusion of nuclear material in *Lilium croceum.* He said he hoped the Society would excuse him for bringing this specimen of extrusion of nuclear material to-night, but he had done so because it was exhibited in a new species. So far as he knew, this was the fourth species in which it had been shown ; he had previously shown it in three. The present slide had been lent to him by a gentleman who wrote to him as a result of the remarks he, the speaker, made some time ago, and which were published in the Journal. It was curious that in all four cases the phenomenon was displayed during the synaptic stage. Anybody who was familiar with the subject of mitosis knew that the synaptic stage was associated with the reduction of chromosomes. He could not account for this, but it was curious that it should be, in every case, associated with the synaptic stage. The present beautiful preparation was made by a Manchester gentleman, to whom he had referred ; it exhibited the fine threads of the synaptic stage in a much better way than did his own preparations.

The preparation of ovo-testis of a frog he regarded as a very remarkable specimen ; for his own part, he did not know that such a thing existed. He thought such a thing as that ought to be considered in relation to the extrusion of nuclear material in the germ-cells of these various lilies. He thought there must be some tendency towards atavism, or a harking-back with regard to fertilization. Whether that was so he did not know, but merely offered it as a suggestion. The slide was submitted to Professor Hickson for examination, who wrote in reply stating it was ovo-testis. Professor Hickson in his letter said that the extrusion of chromatin in the anther-cells was interesting to him, as it corresponded with the extrusion of chromatin from the egg-nucleus of several Alcyonarians and of Pelagia, as described by a German whose name for the moment he had forgotten.

Another point of interest in regard to the extrusion of nuclear material was contained in a letter which had been sent to him by a gentleman of his acquaintance in Southampton. That gentleman who sent him the slide in consequence of his (Mr. Sheppard's) remarks in the Journal, said he had found this associated with a petaloid condition in the anthers. In all the work Mr. Sheppard had done, he had never noticed any abnormality in any of the anthers ; the most he had noticed had been a slight S-curve in the anther, so minute as to scarcely call for notice. The gentleman wrote :—

"I am returning the preparation of *Lilium* showing nuclear extrusion, which is exhibited to an extraordinary degree in this specimen ; in some cases the whole of the chromatin seems to be given up to the adjoining cell. I see that this slide is labelled 'abnormal nuclei,' but possibly the phenomenon may prove to be normal.

"With regard to the suggestion that this phenomenon seems to be associated with a petaloid condition of the anthers, I rather question this, and even if such were the case, it does not seem to carry us much farther towards an explanation. Morphologically, I suppose all anthers are modified petals, and thus far are petaloid, and *prima facie* it does not appear likely that stamens with an atavistic tendency towards a more pronounced petaloid condition should have this phenomenon of nuclear extrusion confined to themselves; I think the explanation will have to be looked for in other directions and on wider grounds. It would be quite easy to examine stamens with petaloid conditions to see if this extrusion is usual in such cases, as many flowers develop occasionally such stamens. I gather from your remarks that such anthers have been examined, and have not exhibited the phenomenon. I must confess that at present I am unable to appreciate on what grounds the petaloid suggestion rests.

"I do not see much difficulty in examining ripe pollen-grains when formed on petaloid anthers, as presumably the anthers could be fixed and cut in the usual way after the ripe grains were formed, but I question whether any information would be gained."

A paper by Mr. **H. J. Howard**, entitled "Notes on *Physarum carneum* G. Lister and Sturgis: a New British Species," was communicated by Mr. Charles E. Heath, and will appear *in extenso* in the next issue of the Society's Journal.

The President and **Mr. A. E. Hilton** commented on this new discovery, as far as England was concerned.

Dr. E. C. Hort then made a communication on "The Life-history of the Meningococcus and other Bacteria," copiously illustrated by microphotographs prepared and exhibited by Mr. F. Martin Duncan, which will appear in the pages of the Journal.

After a short discussion by **Professor Adami** and **Dr. Eyre**, Dr. Hort briefly replied.

The President said he was sure it would be the wish of Fellows to tender to Dr. Hort their heartiest thanks for the extremely interesting evening he had provided. This vote was carried by acclamation.

He also proposed a cordial vote of thanks to Mr. Angus for the loan of the microscopes necessary for the evening's exhibits, though such provision meant the overcoming of great difficulties.

The following Specimens were exhibited :—

By Dr. E. C. Hort :—

1. Giant "Meningococci" in act of gemmation. Benian's "Congo red" film.
2. Comparison film to 1. Gram, counterstained with neutral red.
3. Living Giant "Meningococci" on warm stage in act of gemmation, mixed with normal meningococci. Liquid culture in "Martin-cell" serum-broth.
4. Giant "Meningococci" showing internal segmentation. "Congo red" film.
5. Giant "Meningococci" showing surface gemmation. "Congo red" film

By Mr. H. J. Howard :—*Physarum carneum* ; *P. lateritium* ; *P. penetrale* Rex.

By Mr. D. J. Scourfield, F.Z.S.:—
Sphærœca volvox, a colonial Choanoflagellate.

By Mr. E. J. Sheppard :—
1. Ovo-testis in the frog.
2. Extrusion of nuclear material in *Lilium croceum* in association with the synaptic stage in mitosis.

AN ORDINARY MEETING

OF THE SOCIETY WAS HELD ON WEDNESDAY, MAY 16TH, 1917, AT 20 HANOVER SQUARE, W., MR. E. HERON-ALLEN, F.L.S., F.G.S., ETC., PRESIDENT, IN THE CHAIR.

The Minutes of the preceding Meeting having been circulated were taken as read, confirmed and signed.

The President intimated that a ballot would be taken for the election of the following gentlemen, and subsequently announced that they had been duly elected :—Mr. Ernest Atkinson, Dr. Alfred B. Hichins, Dr. Charles Llewellyn H. Tripp.

The President then called upon Mr. Scourfield to make some observations on the exhibition of Pond-life which had been arranged by Fellows of the Society and Members of the Quekett Microscopical Club.

Mr. Scourfield said that before dealing specifically with the Pond-life organisms exhibited that evening he would like to say a few words about one aspect of the living activities of such organisms, namely, the various kinds of movement which they presented. It was true that all pond-life organisms did not show signs of movement, but it was safe to say that the majority did so, and in any case the question of movement was a very attractive one in itself and one which had by no means been exhaustively investigated. No doubt the different types of movement which were found to occur could be grouped or classified in various ways, but he thought some such scheme as the following would be found useful in considering the matter. First of all there were what might be called the primitive protoplasmic movements. In the last resort, of course, most movements among living organisms were protoplasmic, but some were self-evidently so, and others, such as the movements of flagella, cilia, and muscles, were not. Between the two were certain types, e.g. the movements exhibited by Diatoms, Oscillatoria, and Desmids, which could not be definitely assigned to one or the other in the present state of our knowledge.

Among the primitive protoplasmic movements there were a considerable number of sub-types. Some were entirely intra-cellular without any effect upon the cell-wall. The streaming and circulatory movements within the cells of *Anacharis* and just under the cell-wall in *Closterium*, both of which were being exhibited, were cases in point. Somewhat similar movements could be seen also in many Protozoa.

Then there were movements produced by the extrusion of various protoplasmic processes or pseudopodia as they were usually called. For example, there was the foraminiferal or reticularian type of protoplasmic movement in which one found an almost indefinite extension of actively streaming threads which branched and coalesced or anastomosed in a most bewildering way, forming a marvellous living and moving network. Fortunately he was able to show that evening a living specimen of a fresh-water Foraminifer, a species of *Microgromia*, which, in spite of its small size, illustrated the characteristic reticularian type of pseudopodial movement fairly well, although not to be compared with most of the larger marine forms.

Another form of these primitive protoplasmic movements was what might be called the Filose-Rhizopodal sub-type. It was somewhat intermediate between the foraminiferal and the truly amœboid forms of movement to be considered later. On the whole it was nearer to the former than to the latter, but the pseudopodia scarcely ever showed any tendency to anastomose, and they were not as a rule very numerous. It was well seen in such forms as *Euglypha*, *Cyphoderia*, etc., of which, however, there were apparently no representatives being shown.

A better known and more characteristic kind of protoplasmic movement was the Lobose-Rhizopodal or Amœboid sub-type properly so-called. In this the movement took the form of the extrusion of a number of rather blunt more or less finger-like processes which were continually being given off and reabsorbed by the central protoplasmic mass. The *Amœba* offered the typical example of this variety of movement, and there were several species of that very protean genus on view that evening.

Yet another kind of protoplasmic movement was the Heliozoic sub-type in which the pseudopodia appeared like radiating spines, well seen in the specimen of *Actinosphærium* which was shown under one of the microscopes. It had not yet been satisfactorily explained how the locomotion of the organism was effected by the rigid-looking, though not really rigid, pseudopodia, but movements from place to place certainly occurred, and in some instances rather rapidly.

A peculiar variety of protoplasmic movement in which considerable change of shape occurred, and yet without extrusion of processes, was seen in such forms as *Euglena*, *Astasia*, etc. It might be termed the Euglenoid or metabolic type of movement, and was probably to be regarded as a modification of the amœboid type due to the presence of a permanent though very elastic cell-wall. Unluckily there were no specimens on view which exhibited this peculiar kind of movement.

Coming to the types of movement which were not so evidently protoplasmic as the foregoing, but which were somewhat problematical in their nature, they might take first the Diatomic or Bacillarian movement. This was typically exhibited by species of *Navicula*, *Pinnularia*, *Surirella*, etc., and was undoubtedly a very wonderful phenomenon for which no quite sufficient cause had yet been demonstrated. The evidence, however, seemed to indicate that it would eventually be proved to be essentially a primitive protoplasmic movement, due probably to the flowing of somewhat sticky protoplasm along a groove open to the exterior and usually situated in the raphe. At any rate, something which could adhere to particles of debris certainly moved backwards and forwards along the raphe, or along the keels in the case of *Surirella*, and it was difficult to imagine what this could be unless it were protoplasm. Several exhibits included motile Diatoms in addition to the principal object shown.

There was next the Oscillatorian type of movement, that snake-like, creeping, gliding, bending, rotating movement exhibited by species of *Oscillatoria* and allied genera, of which some specimens were being shown that evening, and also by such bacterial forms as *Beggiatoa*. It was, perhaps, the most mysterious of all the types of movements exhibited by microscopic organisms, and nothing approaching a satisfactory explanation had yet been given of it in spite of various hypotheses and many positive assertions as to the presence of cilia, etc.

The movements of Desmids, too, while in some ways resembling those of Diatoms and Oscillatoria, although much slower, appeared to have peculiarities of their own which entitled them to be considered as belonging to a distinct type—the Desmidian type, as it might be called. In some cases it was probably due to the exudation of mucilage, but this scarcely seemed sufficient to account for the remarkable way in which Desmids would extricate themselves from a confused mass of sediment and gather together on its surface. There were several exhibits that evening showing various species of Desmids, but the time available was probably too short to allow of a demonstration of their movements.

Leaving these somewhat obscure types of movement, they had next to consider the very definite type of flagellate movement. A flagellum was the source of locomotion in a very large number of minute microscopic forms, both vegetable and animal, and, without much doubt, the movement was due essentially to a rapid series of waves or bends of greater or smaller magnitude running along the flagellum. It had been thought that the motion of a flagellum was of a spiral or corkscrew type, but this was certainly not true in all cases. Ulehla had shown that the light-space produced, under high-power dark-ground illumination, by a flagellum in motion was of very varied form, often curved or bent, usually broader in one view than in the other, and that sometimes it was even at right angles to the line of progression of the organism. These facts were clearly incompatible with the idea of a spiral action, although not with that of a series of waves running continuously along the flagellum. Much work, however, was required to demonstrate the true action in individual cases. Apparently no flagellate organisms were being shown that evening.

Passing on to ciliary movement, it was to be noticed that in this type they had to deal with co-ordinated movement of a large number of vibrating filaments, for, in contrast to flagella, cilia always occurred together in considerable numbers. The action of a cilium was certainly different to that of a flagellum, and was probably essentially a lashing to and fro, quicker in one direction than in the other. The lashing of the different rows of cilia did not take place exactly at the same moment, but there was a sort of rhythmic impulse communicated along the lines producing an effect similar in appearance to the waves caused by the wind passing over a field of corn. A very large number of microscopic animals were furnished with cilia, and they had many examples among the exhibits, e.g. *Paramœcium*, the Rotifers, and the Polyzoa.

Lastly, there was muscular movement. It was doubtful if this type of movement occurred among the Protozoa, the nearest approach to muscle structure in that group being probably the contractile fibril found in the stalk of *Vorticella*. Even in *Hydra* the muscular system was very rudimentary, consisting of elongated contractile processes arising from the bases of the ectodermal and endodermal cells. In all the groups higher than the Hydrozoa, however, muscular movement was commonly in evidence. In the worm types, Turbellaria, Rotifera, Gastrotricha, etc., and in the Polyzoa such movement was quite usual, although more often than not it was accompanied by movement due to cilia. In the still more highly organised Arthropod types, Entomostraca, Hydrachnida, Tardigrada and Insecta, practically all movements were muscular. Many of the specimens exhibited would be found to illustrate muscular movement and also the various ways in which it was applied to produce locomotion of the organisms.

Mr. Scourfield then proceeded to refer in detail to the various exhibits.

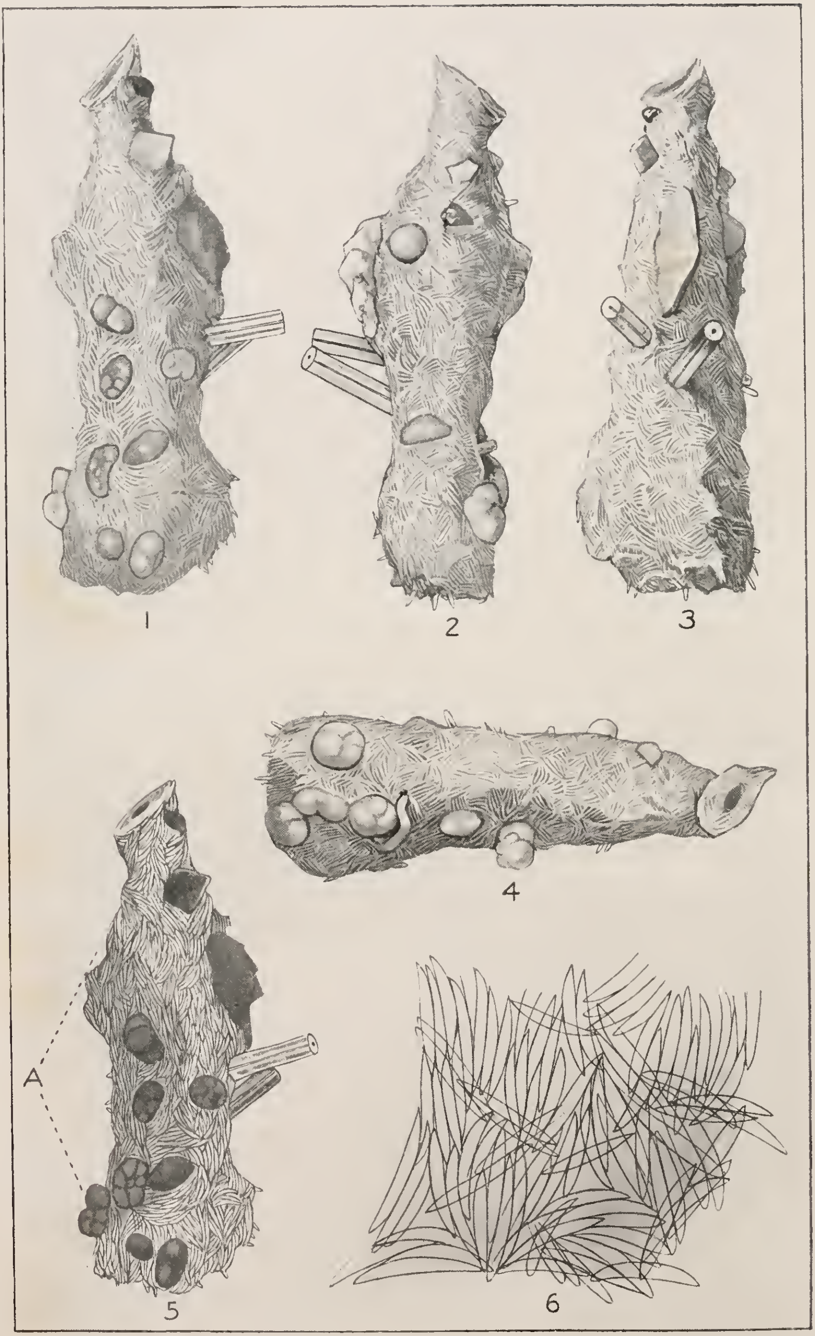
The President moved from the Chair hearty votes of thanks to the Exhibitors of the Pond-Life specimens, and to Mr. Scourfield for his remarks upon them.

It was announced that the Biological Section would meet on June 6, when Mr. R. Paulson, F.L.S., would make a communication on *Melanconis stilbostoma*, a tree-destroying fungus.

The following Objects were exhibited :—

Mr. E. E. Banham	*Cristatella mucedo.*
Mr. L. C. Bennett	*Callidina vorax, C. plicata*, etc.
Mr. C. H. Bestow	*Fredericella sultana, Hydra viridis.*
Mr. N. E. Brown	*Closterium lineatum*, conjugating.
Mr. J. Burton	*Oscillatoria, Phormidium, Lyngbya.*
Mr. W. R. Chapple	Red Water-mite.
Mr. F. W. Chipps	*Lophopus crystallinus* ; *Plumatella repens* (young, from statoblasts).
Mr. Thos. N. Cox	*Anacharis*, showing cyclosis.
Mr. E. Cuzner	*Lophopus crystallinus.*
Mr. D. Davies	*Ephemera* larva.
Mr. A. Downs	*Brachionus* sp.

Mr. F. Martin Duncan .	*Amœba* (two species).
Mr. L. N. Hensman . .	*Closterium Lunula.*
Mr. A. E. Hilton . . .	*Lophopus crystallinus.*
Mr. A. Morley Jones . .	*Brachionus rubens.*
Dr. J. R. Leeson . . .	*Paludicella ehrenbergi.*
Mr. J. Milton Offord . .	*Brachionus rubens* on *Daphnia pulex.*
Mr. R. Paulson . . .	*Paramœcium bursaria.*
Mr. J. Perks	*Draparnaldia plumosa.*
Mr. F. J. W. Plaskitt. .	*Navicula* sp.
Mr. John Richardson . .	*Hydrodictyon reticulatum.*
Mr. D. J. Scourfield . .	*Microgromia* sp.
Mr. R. S. W. Sears . .	*Micrasterias rotata, M. denticulata, M. truncata, Closterium Lunula, C. acerosum, Euastrum oblongum,* etc.
Mr. W. R. Traviss . .	*Paludicella ehrenbergi.*
Mr. H. C. Whitfield . .	*Ephemera* larva (tail), under Rheinberg multi-colour stop.
Mr. J. Wilson	*Micrasterias, Closterium, Pleurotænium, Amœba* sp., *Lecquereusia spiralis, Actinosphærium eichhornii.*



J. R. Ford, del.

Nouria rugosa.

JOURNAL

OF THE

ROYAL MICROSCOPICAL SOCIETY.

AUGUST, 1917.

TRANSACTIONS OF THE SOCIETY.

V.—*On some Foraminifera from the North Sea, etc., dredged by the Fisheries Cruiser "Goldseeker" (International North Sea Investigations—Scotland).* IV. *On Nouria rugosa: a New Species of Foraminifera from the Faroe Channel.*

By Edward Heron-Allen, F.L.S. F.Z.S. Pres.R.M.S., and Arthur Earland, F.R.M.S.

(*Read June* 20, 1917.)

Plate XXIII.

The genus *Nouria* was instituted by the authors in 1914,* for the reception of certain Lituolinæ isomorphous with the hyaline genera *Polymorphina* and *Bolivina*. Three species were then described, from localities as widely separated as Portuguese East Africa, the Philippine Islands, and New Zealand; two of which species, viz. *Nouria harrisii* and *N. compressa*, showed strongly-marked selective powers in the utilization of sponge spicules for the construction of their tests.

A further representative of the genus has since been found which presents the same characteristic habit in a somewhat lesser

* Trans. Zool. Soc. Lond., xx. pt. 1 (Nov. 1914) pp. 375–9, pl. xxxvii. figs. 1–26.

EXPLANATION OF PLATE XXIII.

FIGS.

1–4.—*Nouria rugosa* sp. n. Viewed by direct illumination in different positions. × 37.

5.—Viewed by transmitted light. The dark area within the dotted lines A represents the first or internal chamber. × 37.

6.—Detail showing arrangement of spicules viewed by transmitted light. × 150.

degree. It differs in many features from the species already described, and we propose for it the specific name *rugosa* in consequence of the warted or tufted external surface which its very characteristic method of construction entails.

The specimen on which the species is founded was dredged by the Scottish Fisheries' cruiser "Goldseeker," from a depth of 330 metres, in the Northern Area of the Shetland-Faroe Channel. Station XVIIIA lies in 60° 57′ N. latitude and 5° 47′ W. longitude on the Faroe side of the Northern or *cold* area of deep water. The depth at this Station is very variable; no two hauls ever agree within many fathoms, and the bottom is foul. No doubt the Station lies among submarine gorges and cliffs rising from the deep water to the submerged plateau which surrounds the Faroe Islands. Dredge and trawl usually bring up only a mass of stones, with abundant Echinoderm and sponge fauna, and some dark basaltic sand. Foraminifera are varied, but not particularly abundant.

So far we have only met with a single specimen of *Nouria rugosa*, in spite of an exhaustive search, but time and patience will no doubt provide more material. Meanwhile for purposes of record a description and figures based on the individual specimen must suffice.

Nouria rugosa sp. n.

Test free, polythalamous, consisting of at least two chambers, the last-formed chamber completely enclosing its predecessor, the presence of which is only disclosed when the specimen is viewed as a transparent object.

In shape roughly fusiform, bulbous at aboral end, somewhat constricted in the middle and tapering at the oral extremity to a short thick neck, which is cut off obliquely and terminates with an inverted lip round a central aperture.

Greatest length exactly 2 mm. Greatest breadth at bulbous extremity 0·8 mm., narrowing rapidly from this point to a diameter of 0·5 mm. in the widest part of the constricted body. Diameter of apertural end 0·27 mm.

The test is built up of small sponge spicules, of curved *oxea* type with obtusely blunted points. These spicules are of remarkably uniform size, measuring rather less than 0 1 mm. in length. They are regularly arranged in a single superficial layer, generally in groups having the convex edge of one spicule fitting into the concavity of the next, thus forming little patches with even regular surface. The curved shape of the spicules necessitates a frequent change of direction in the arrangement of the spicules, resulting in adjacent patches of opposed curves. Such patches, of course, entail a space or *lacuna* between them, a space less than a spicule in length. Such interstitial spaces appear to be closed by the insertion of a spicule or bunch of spicules, at right angles to the general plane of construction, with the points projecting from the outer surface or into the interior of the test. At intervals, also, the organism gathers in the slack, so to speak, by forming a projecting cusp with a bundle of spicules, the projecting ends of which can be seen round the edges and base of the test. These factors combine to give a curiously irregular or warted appearance to the test, from which we give it the name *rugosa*.

Imbedded in the surface of the test are many other foreign bodies, the most prominent of which are two large broken megascleres projecting from the middle of the test. There are also one or two large shell fragments and a number of small Foraminifera (*Globigerina* and *Pulvinulina*) imbedded in the wall. Although these foreign bodies, owing to their large size and projecting surface, take a very conspicuous part in the external appearance of the specimen, they form but a very minor feature in the construction of the test, which is primarily constructed of carefully selected *oxeas* of minute and uniform size. Curiously enough, sand grains appear to be almost, if not entirely, discarded in construction, although abundant in the animal's environment.

We have not as yet succeeded in identifying these *oxeas* with any of the sponge debris, of which the dredging largely consists, but we have no hesitation in deciding that they are foreign bodies selected by the organism, and not spicules secreted by the animal for constructive purposes. Their minute size and the absence of broken spicules might perhaps suggest a secreted origin for the moment, but their siliceous nature, and the comparatively irregular method of their arrangement as compared with the systematically deposited calcareous spicules of *Carterina*—the only marine Rhizopod known to secrete a spicule—would at once refute such a theory, apart from the presence of the other foreign bodies built into the shell. No doubt the spicules will be identifiable by a specialist in Sponges.

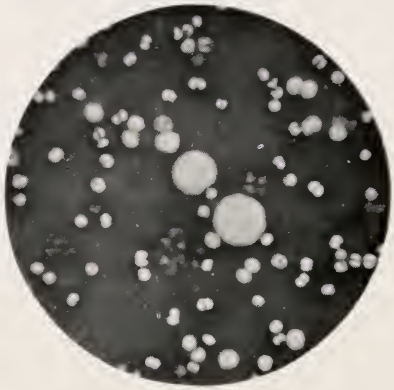
Nouria rugosa in its constructive methods appears to occupy a position intermediate between *N. polymorphinoides* H-A. & E. and the two other species, *N. harrisii* H-A. & E. and *N. compressa* H-A. & E. *N. polymorphinoides* H-A. & E. employs sand and mineral grains, rarely or never spicules, in the construction of its test, and exhibits a certain amount of care in their selection, while the two other species use spicules to the exclusion of all other substances. *N. rugosa*, in other words, is a less finished workman than *N. harrisii* or *N. compressa*, but superior to *N. polymorphinoides*.

As regards isomorphism, it would not be wise to say much on the evidence of a single specimen which may not be mature, but the shape and position of the chambers suggest a comparison with

Polymorphina angusta Egger or *P. lanceolata* Reuss. Of the earlier described species, *Nouria polymorphinoides* is isomorphous with *Polymorphina compressa* d'Orb., and occasionally with *P. oblonga* Williamson; *Nouria harrisii* has similar affinities, while *N. compressa*, which is almost Bolivine in its plan, may perhaps be compared with *Polymorphina complanata* d'Orb., or *P. frondiformis* Searles Wood.

We take the present opportunity of recording *Nouria polymorphinoides* H-A. & E. from European waters. One small but fairly typical specimen has been found in a dredging off the Faroe Islands, "Goldseeker" Station XVI. 62° N. 6° 12'., depth 128 metres.

1



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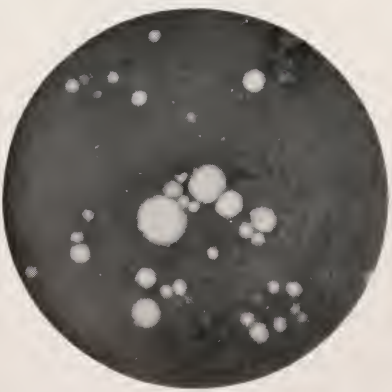

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VI.—*The Life-history of the Meningococcus.*

By Edward C. Hort, F.R.C.P. Ed.

(*Read April* 18, 1917.)

Plates XXIV and XXV.

In November of last year I enjoyed the privilege of demonstrating to this Society, with the aid of Mr. Martin Duncan's microphotographic skill, some morphological phases in the life-history of certain bacteria, such as the *Bacillus exanthematicus* of typhus fever, and the organisms of the enteric group.

You will perhaps remember that the object of my demonstration was to present evidence, admittedly incomplete, that the lower bacteria are not necessarily what they seem to be, and as we are taught, namely, unicellular organisms with a simple life-history. So far, indeed, from their life-cycle being a simple affair, beginning and ending with transverse binary fission into two equal parts, the evidence, such as it was, suggested that the life-history of bacteria is one of great complexity, and includes, in some cases at least, a minute filterable, and invisible, or almost invisible, stage.

To advance such a doctrine as this in the face of up-to-date bacteriological teaching is to proclaim oneself a heretic, and to invite the doom that awaits all heretics.

As, however, I have not yet been led to the stake, I venture to ask you once again to examine very briefly, as you did last November, the articles of faith of the orthodox bacteriologist, who

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EXPLANATION OF PLATES XXIV. and XXV.

FIGS.

1.—Meningococcus. Case 4. Cerebro-spinal fluid incubated two nights, then on serum-agar one night. Benian's Congo-red film. × 1500.

2.—Case 3. Plymouth. Cerebro-spinal fluid incubated two nights, then placed in acid broth two nights; then in serum-broth one night. × 1500.

3, 4.—Meningococcus. One colony, on serum-agar from incubated cerebro-spinal fluid containing budding cysts and meningococci. Fermenting glucose only. Spread on serum-agar. Confluent growth A.S.B. × 60 to Phen; then incubated five days. Centrifuged, and examined in Congo-red. × 1500.

5.—Case 3. Plymouth. Cerebro-spinal fluid incubated two nights, then placed in acid broth two nights. × 1500.

6.—Case 3. Plymouth. Cerebro-spinal fluid incubated two nights, then placed in acid broth two nights; then in serum broth one night. × 1500.

7, 8.—Meningococcus. Serum broth. Benian's Congo-red film. × 1650.

very properly supports the teaching of the schools. If, says he, an aberrant morphological type of organism appears in my cultures, it is one of three things—it is either a contaminant, or it is an involution form, or, if he is a brave man, it is a mutant. But whichever of the three he thinks it is, he throws away his cultures and starts afresh. And he does this because he is firmly convinced that the lower bacteria can only reproduce themselves —apart from endosporulation of a special type in certain cases—by equal binary fission, this belief being itself founded on the unquestioned fact that bacteria do breed true to type in standardized laboratory media.

But, as you may remember, I ventured in answer to these arguments to formulate four propositions:—

1. That it is just as dangerous to assume that a given organism is a contaminant, without the most searching enquiry, as it is to assume that it is not.

2. That to call an aberrant morphological type an involution form, especially when it occurs in young and suitable media, is to take refuge behind a label which under such circumstances means nothing at all.

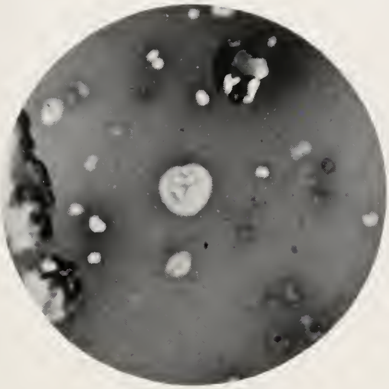
3. That the fact that bacteria breed true to type (to laboratory type) in test-tubes under the highly artificial condition of laboratory culture cannot reasonably be taken as evidence that the test-tube method of reproduction is the sole method of reproduction under natural conditions.

4. That if the orthodox view as to the simplicity of the life-cycle of bacteria be true, the phenomenon has practically no parallel in comparative biology.

On theoretical grounds alone, therefore, I urged that the present view is not likely to be the correct view, and that in order to examine the evidence for the opposite view with an impartial mind, it is absolutely essential that we should not invoke too easily the contaminant, the involution form, the mutant, *et hoc genus omne,* in order to escape our difficulties.

This, of course, is not to say that the most rigid precautions against error should not be taken, as the description of the technique to be presently described will, I hope, show.

It is, of course, fully recognized that innumerable observations have been recorded in the past of aberrant morphological types occurring in apparently pure cultures of bacteria, especially when their cultural environment was altered. Excellent illustrations of this may be seen, for example, in Besson's pictorial description of the *Bacillus pyocyaneus,* and of the *B. anthracis.* The first point, however, I wish to make is, that if patience be employed it is often possible to show the presence of aberrant morphological types without change of cultural environment. It is therefore unnecessary, provided that optimum conditions of cultivation are



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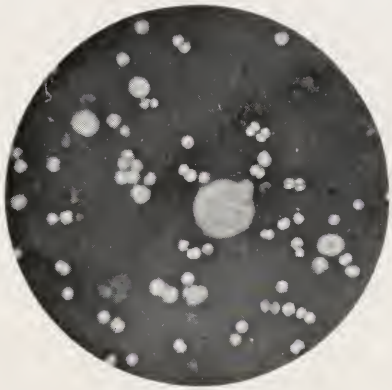

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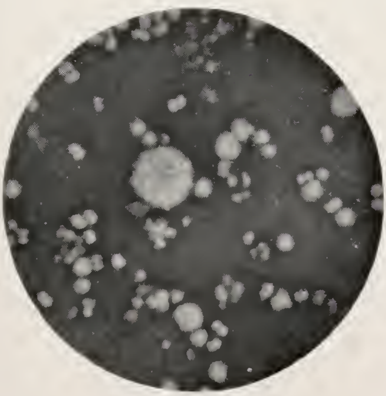

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employed, to invoke the theories of involution forms, or of mutation, in order to explain these genuine types of pleomorphic activity. A more reasonable, and much simpler, explanation of bacterial pleomorphism lies, in short, in the view that these aberrant types merely represent different stages in the life-history of bacteria. And this view is strongly supported, if not absolutely proved, by actual observation, on the warm-stage, of the development of single individuals. And in this connexion it is well to remember that excellent precedent is afforded for this explanation by demonstration of the fact that the Discomyces and Sporotricha, to mention only two groups, are not bacterial at all, as they were for long considered to be.

So much by way of introduction.

To-day Mr. Martin Duncan and I propose to put before you fresh evidence in support of my thesis that the lower bacteria are not necessarily what they seem to be. And the organism I have selected for this purpose is the meningococcus of Weichselbaum.

It is generally taught, and it is widely believed, that the meningococcus of Weichselbaum is the direct casual agent of that form of epidemic cerebrospinal fever with which the meningococcus is usually associated.

It is also taught, and it is generally accepted, that the meningococcus—as one of the "lower" bacteria—is an organism with a simple life-history, reproduction taking place exclusively by the process of binary fission into two equal parts, a meningococcus always arising from a meningococcus, and in no other way.

As regards the first of these propositions, that the meningococcus is itself the cause of epidemic cerebrospinal fever, I showed by experiment in 1915—and this, in conjunction with Captain Caulfeild, I amply confirmed in the following year—that the theory cannot be accepted for this simple reason, viz. that cultures of the meningococcus in cerebrospinal fluid, or in laboratory media, frequently contain a filterable virus which is just as pathogenic to monkeys (though not necessarily productive of the disease) as are unfiltered cultures.

It follows from this, notwithstanding many statements to the contrary, that the disease has not yet been produced experimentally in animals by injection of pure cultures of Weichselbaum's organism. There is, in fact, no evidence that the meningococcus as such is responsible for the disease.

It is true that an attempt was made to discredit my results by the suggestion that the filterable virus referred to was a toxin. But there is no toxin known to us which is directly capable of producing continued fever lasting for many weeks, after the lapse of a well-marked latent period. And completely negative bacteriological examinations of the animals in question excluded the indirect action of a theoretical toxin in producing the results observed.

The demonstration of the presence of this filterable virus in meningococcal cultures had, in addition, this important result, that it showed quite clearly that the second proposition of the text-books to which I have referred—namely, that the meningococcus is a bacterium with a simple life-history, beginning and ending with simple binary fission—is probably not true. It unmistakably suggests, in fact, that the meningococcus represents one phase only in the life-cycle of an organism which has not yet been described.

The object of the present communication is, as I have said, to show yet another phase in the life-history of the unknown causal organism of epidemic cerebrospinal fever, though I wish to make it perfectly clear that even now the whole of the mystery is not cleared up, and that there are still other phases which require further study.

I shall, therefore, here confine myself to what may be learnt by study of the so-called giant meningococcus, which is generally believed to be a large involution form of Weichselbaum's organism, but which is in reality, as you will see, not a bacterium at all—not even a diseased bacterium, as your Secretary humorously would put it. Before, however, Mr. Martin Duncan shows you his slides, it is necessary very briefly to summarize what is at present known as regards the morphology of the meningococcus and its alleged involution forms.

The meningococcus, which is usually only studied in cultures on solid media, is a Gram-negative coccus, occurring singly or in pairs, often with flattened opposed surfaces, sometimes in triads or in tetrads, but never—the text-books say—in chain formation, except as a result of accidental apposition. Heiman and Feldstein also describe giant cocci, four to five times the size of a normal coccus, which in diplococcoid form measures roughly 1 m. in diam. These giant cocci stain intensely with whatever counterstain is employed in Gram preparations, and are believed by these authors to be involution forms, and are said to be only seen in cultures up to forty-eight hours old. In some cultures, as I recorded in 1914, extremely minute cocci are also to be seen mixed with the larger normal forms, and with the so-called giant cocci. And between these very minute forms and the normal forms, intermediate forms of every grade in size are sometimes to be made out, sometimes in diplococcoid form, and at others in single coccus form. In some of the normal-sized cocci, and occasionally in the giant forms, a central bright spot has been described (staining deeply with alkaline-methylene blue)—not to be confused with the clear space, sometimes remarkably wide, which may be seen between the two members of a dividing coccus.

The prescnce of the giant forms appears to receive no notice in the English text-books, faithful to the general tradition that bacterial morphology does not merit serious study. And in no description of the meningococcus that I have seen in any language has there appeared any account of observations of growth of this organism, or of the giant forms, on the warm-stage, an omission, as will be seen, which explains a good deal.

From this brief résumé of the present state of knowledge of the morphology of the meningococcus, there is clearly a good deal to suggest that further enquiry was necessary as to the supposed botanical position of that organism. We have here, for example, an organism which varies very greatly in size, which sometimes occurs in chains, whether accidentally produced or not, and which sometimes has a central bright spot, giving in unstained preparations a clear space, strongly suggestive of a false spore. And, finally, we have giant forms appearing repeatedly in young suitable cultures of a few hours old, which, on that account alone, are most unlikely to be involution forms ; as well as very great variation in size of " normal " meningococci, not only in cultures from one case, but also in cultures from one case as compared with cultures from another case. Anyone, for example, who has studied the morphology of Gordon's so-called strain No. 2 in liquid cultures cannot but have been struck with the large size of the normal individuals present, as compared with those often seen in cultures from strain No. 1. So aberrant, in fact, are they often found to be, that it is difficult to believe that they are true meningococci, either in size or shape.

So much for current descriptions of meningococcal morphology, as studied mainly on solid media.

We come now to my own studies of the morphology of the meningococcus in liquid media, subcultured from solid media. And here let me say, that in attempting to determine the true botanical position of the meningococcus, or of any other reputed bacterium, it is often fatal to restrict one's observations to growth on solid media only, however convenient these may be for purposes of identification.

In the case of the meningococcus, I have so far only once succeeded in obtaining free growth on solid media of the organism we will now show you, although I had no difficulty in obtaining free growth in thirty-six consecutive acute cases of cerebrospinal meningitis from primary colonies on serum-agar.

In every case the meningococcus has been isolated and fully identified, by its staining reactions, its morphology, its sugar reactions, and its serological reactions, and by certain well-defined cultural reactions, many of which are not in the text-books. I have not found the largest forms in any case apart from the meningococcus, and in no case has the meningococcus been found without these organisms being also found. I have never been able to cultivate them in pure culture apart from the meningococcus, and in every apparently pure culture of the meningococcus these organisms have always been found if diligently searched for.

They can be demonstrated in incubated cerebrospinal fluid, collected with every precaution against contamination ; and they can be demonstrated, if searched for, in single colonies on serum-agar plates, provided that these have been inoculated with incubated cerebrospinal fluid. The best and most certain method, in fact, of demonstrating their presence has been, in my hands, by subculture from single colonies on serum-agar, itself inoculated with incubated cerebrospinal fluid. This subculture, however, must be into liquid media, an excellent medium being equal parts of tested horse-serum and broth, the reaction of which to phenophthalein may be + 10, + 30, or even + 50.

The technique I have mainly employed for the detection and cultivation of the organism is as follows :—

1. Cerebrospinal fluid from a suspected case of the disease is discharged direct into a sterile glass flask, with a specially-ground glass stopper provided with a sterile rubber cap sufficiently large to come well down over the neck of the flask. In each case only samples of fluid withdrawn at first lumbar puncture have been employed.

2. On arrival at the laboratory the centrifuged deposit from a small quantity of the fluid is examined.

3. The remainder of the fluid is then incubated at 37·0° C. for a period varying from forty-eight to seventy-six hours.

4. A further volume of the fluid is now withdrawn from the flask, and is centrifuged and examined.

5. Of six cases in which prolonged examination was carried out of films prepared from the deposit of the incubated fluid, the organism has been found in three.

6. Two or more serum-agar slopes, and sometimes, in addition, three serum-agar plates, are now incubated ; the plates in series with considerable volumes of the incubated cerebrospinal fluid.

7. On the following day likely single colonies are picked off, and are individually spread on to fresh serum-agar slopes to provide a free confluent growth.

8. On the following day the entire growth of each slope is inoculated into serum-broth tubes, which are incubated for forty-eight hours.

9. From the serum-broth tubes fresh serum-agar and agar slopes are inoculated for serological tests ; and lactose, saccharose, glucose, mannite, and dulcite tubes are also inoculated from the same source.

10. Samples of the serum-broth tubes are at the same time, and subsequently every day, centrifuged and the deposits examined.

11. The serum employed in each case is thoroughly tested as

regards sterility by complete bacteriological and experimental tests, monkeys being employed for the latter.

By taking these precautions, and by replating at each stage and retesting from single colonies, both with fermentation and serological tests, as absolute a guarantee as it is possible to obtain by observation of cultures from single colonies is assured.

However useful for purposes of identification, and for ensuring sterilization as far as may be, cultivation from single colonies cannot, nevertheless, give an absolute guarantee of sterility. To obtain this only two methods are open to us. The first is to pick off single meningococci from a solid culture, and to place each individual into a separate tube containing a suitable liquid medium, in the hope of successful cultivation therefrom.

This is the classical method, and in theory it is ideal. In practice, however, it cannot be relied on, and for this reason. As I have previously shown, the presence of the minute filterable virus frequently to be found, and even to be seen as very minute organisms, in meningococcal cultures, makes it impossible to be certain that in picking up a normal-sized meningococcus one is not at the same time picking up one of these smaller forms. Now, the smallest of these forms are, as I have repeatedly tested, quite invisible under a dry lens, and the highest compensating ocular that will allow of good illumination. Even with a magnification of 3000, as obtained with a 1·5 mm. apochromatic oil-immersion lens and the appropriate tube-length and compensating ocular, it is still impossible to be certain that one organism, and one only, has been picked up. The photograph of the camera lucida drawings will illustrate this point, and this applies both to Barber's method and to the fragmented cover-slip method. The only alternative, therefore, is actually to watch on the warm-stage growth from a single organism, and even here, on account of these extremely minute forms, the problem is one of great difficulty.

After innumerable trials I have however partially succeeded, as you will see.

Owing, however, to the fact that these giant forms are apparently loth to grow on solid media, it became necessary to devise a method of observing growth in liquid cultures, the hanging-drop method of course being useless for the purpose owing to the shape and depth of the drop.

There are two ways, both of which you will see illustrated on the screen, of studying growth in liquid cultures on the warm stage.

The first—not very satisfactory, owing to rapid drying—is to make a thin film of serum-broth culture under a cover-slip on an ordinary sterile slide covered with a thin layer of fresh serum-agar. In successful cases growth of the giant forms, showing exogenous gemmation and endosporulation, can be observed in the thin layer of liquid before this has dried, and before the meningococci present have had time to "bite" into the solid medium. Flexible collodion makes a good seal, but drying at incubator temperature still takes place in three to five hours, and owing to the use of an oil-immersion lens the employment of a moist chamber does not appear practicable.

The alternative method of watching growth in liquid culture was to make shallow cells, as suggested by Mr. Martin Duncan, who made several for me of shellac varnish on an ordinary slide, and to cover with a sterile slip, inserting sufficient medium to ensure flooding of the top of the walls of the cell, and, in consequence, automatic sealing thereof by capillary attraction. I now employ cells made with black enamel, which stands sterilization better than the shellac, each cell being about one-tenth of a millimetre in depth.

By this method relative immobilization of the organism under observation is secured, and on the whole the method gives satisfactory results.

These results, however, require the greatest care in interpretation, owing to the presence—firstly—of the almost invisible organism referred to, early gemmation and endosporulation being often exactly simulated by minute organisms brought into apposition by slight streaming movements still persisting; and owing—secondly—to slow rotatory and dipping movements. These movements lead to error, unless careful and prolonged watch is made, because an early bud, or a minute endospore, under observation may either temporarily vanish from view, or without having been previously seen may come into view for the first time, and simulate a fresh bud or endospore.

In all cases, therefore, most tedious and prolonged observation is necessary, which ought to be repeated again and again with fresh cultures.

By the use of these cells cultures can be kept liquid for forty-eight hours without difficulty. Disappointment is, however, frequent, owing to death, or arrest of growth, of an individual organism under observation.

Illustrative Fermentation and Serological Tests of Serum-broth Cultures of the Meningococci employed in the above Observations.

Fermentation Reactions.

In the case of all the fourteen cultures, details of which are here recorded, no reaction was observed in lactose, saccharose, mannite, or dulcitol.

In twelve of the cultures acid was produced quite definitely in glucose. In the remaining two cultures no acid was produced in glucose.

In every case incubation at 37°C. was continued for eight days.

Serum Reactions.

Dilutions ..	1/4	1/8	1/16	1/32	1/64	1/128	1/256	Control
Culture 1 ..	C	C	C	C	C	C	C	nil
,, 2 ..	C	C	C	C	C	P	nil	nil
,, 3 ..	C	C	C	C	P	nil	nil	nil
,, 4 ..	C	C	C	C	C	nil	nil	nil

In the case of these four cultures the dilutions were made from undiluted meningococcal serum supplied by the Lister Institute.

Titre, 1/250 ; No. Cl. ; date of tubing, 9/2/16 ; dates of agglutination, 8/3/16, 4/3/16, 29/4/16, 29/4/16.

Incubation at 37° C. was allowed for twenty-four hours before reading, plus one hour at room temperature.

C = complete agglutination.

P = partial ,,

The agglutination tests of the remaining ten cultures were kindly carried out by Dr. Lawes, using Gordon's method for identification of "strains."

The agglutination tubes and their contents were incubated at 56° C. for twenty-four hours before being read.

	Normal	I.			II.			III.			IV.		
		a	*b*	*c*	*a*	*b*	*c*	*a*	*b*	*c*	*a*	*b*	*c*
Cult. 5	–	++	++	++	–	–	–	+	–	–	–	–	–
,, 6	–	–	–	–	++	++	++	–	–	–	–	–	–
,, 7	–	–	–	–	– –	– –	– –	–	–	–	–	–	–
,, 8	–	++	++	++	–	–	–	–	–	–	–	–	–
,, 9	–	++	++	+	–	–	–	–	–	–	–	–	–
,, 10	–	–	–	–	++	+	–	–	–	–	++	++	+
,, 11	–	–	–	–	++	++	+	–	–	–	–	–	–
,, 12	–	–	–	–	++	++	++	++	(+)	–	–	–	–
,, 13	–	–	–	–	++	++	++	–	–	–	–	–	–
,, 14	–	–	–	–	++	++	++	–	–	–	–	–	–

Cultures 8 and 9, 11 and 12, 13 and 14, were from three cases ; cultures 1 to 7, as well as culture 10, being from eight separate cases ; *a*, *b*, *c*, represent respectively dilutions 1/100, 1/200, 1/400.

In summing up this demonstration of the morphology of the meningococcus and of the so-called giant forms, I suggest the following order of events, by no means dogmatically or finally, as the subject is one of the greatest difficulty. Starting from one of the giant forms, whatever its true botanical nature, whether related to the yeasts or not, what appears to happen is this:—A giant form will start the process of single, or multiple, gemmation. I have not seen one of these buds actually separate from the mother-cell. But I have seen them grow from extremely minute buds to a considerable size, and in so doing give off secondary and even tertiary buds. Each, or all, of these buds, as well as the original mother-cell, may at the same time, or independently in point of time, show one or more small rounded bright bodies, by a clear process of endogenous segmentation. They may be centrally placed or peripherally. Some of them will rapidly enlarge, but they never appear to attain the size of a freely growing, exogenously produced bud. Sometimes they will suddenly disappear from the mother-cell, and as suddenly reappear either at the periphery of the mother-cell or away from it. Sometimes they may be seen in what appears to be a process of extrusion, when they may take on a diplococcal form of about the size and appearance of a normal meningococcus. In some of the mother-cells, whilst this is going on, minute black spots will appear in the mother-cell, sometimes centrally and sometimes peripherally. Eventually they tend to become aggregated, in symmetrical fashion, round the periphery of the cell, where they will often assume a definitely minute bacillary form. In some cases, whilst situated centrally, these minute black spots will move about with incredible rapidity (? Brownian movements) inside the mother-cell, and several times I have seen what appears to be a sudden extrusion of one or more of these (? metachromatic) bodies, after which they are no more seen.

Whether these bodies may possibly be of the nature of swarm-spores I cannot say. There is still a highly significant point to mention, which is this. In every meningococcal culture I have examined on the warm-stage in the liquid culture cell described, I have noticed the development of rounded single cocci from the normal size of a normal meningococcus into what appear to be giant cocci, no evidence of binary fission being present. On the contrary, if they are focused in the small stage, the appearance of diplococcoid formation is often simulated, whilst on still further observation it is seen that the segments are unequal in size, the smaller segment being in reality a minute bud in the process of formation. These organisms appear, therefore, to be detached buds, developing again into giant forms.

And there, incomplete as the story is, I must for the present leave it.

VII.—*A Note on Fertilization and Deposition of Ova in Portunus depurator.*

By F. Martin Duncan, F.R.M.S. F.R.P.S.

(*Read June* 20, 1917.)

Some years ago, and again recently, I had an opportunity of observing a process in connexion with the deposition of ova by one of our British "Fiddler" crabs, *Portunus depurator*, which I believe is not very generally known, and is of considerable interest.

The female crab, if captured at the time when she is "in berry," as it is termed by the fishermen, will be seen to carry the masses of ova under the tail, the eggs being attached to specialized processes, and looking like bunches of grapes. If a healthy female in such condition be kept under observation in a glass tank well supplied with sea-water, she will in the course of a few days or longer period deposit the whole of her visible ova in the normal way; the ova resting on the floor of the tank, and attached to one another in the typical manner. These ova will, of course, duly undergo segmentation, and develop into Protozoæa, which will pass through the various stages connected with their metamorphosis ere reaching the adult stage. Should the female crab at the end of the deposition of this batch of ova be removed to another tank, and kept under further observation, she will probably in the course of a week or ten days be found to have deposited a fresh quantity of ova, which, however, are not attached to each other, but are scattered like grains of sand upon the floor of the tank. These ova, although there has been no intercourse with a male crab since the first batch was deposited, will also undergo segmentation and give rise to Protozoæa which complete their metamorphosis. Their fertilization, however, has not been due to the presence of free-swimming spermatozoa in the sea-water, as appears to have been hastily surmised by some observers. This can be proved, and the true significance of this second deposition of ova better appreciated, by carefully filtering the sea-water through two or more thicknesses of filter-paper, so as to preclude all possibility of free-swimming spermatozoa being present in the second tank when the female crab is placed therein.

It is, I believe, a well-established though not very generally known fact, that one impregnation of the female crab suffices for the fertilization of two or more depositions of ova, the spermatozoa being retained by the female in a "*receptaculum seminalis*," and the ova fertilized from this supply at the time of deposition. I have not had an opportunity of observing the act of copulation in *Portunus*, but one may suppose that in all probability it takes place very shortly after the female crab has moulted, and before her shelly armour has had time to harden. That certainly appears to be the case as regards the Common Shore Crab (*Carcinus mænas*), and the remarkable little Masked Crab (*Corystes cassivelaunus*), which on several occasions I have watched on the wide sandy shores of Dymchurch Bay.

This interesting phenomenon of repeated depositions of fertile ova, as the result of one impregnation by the male crab, has also been observed by my friend, Mr. H. J. Waddington, of Bournemouth, whose beautiful preparations of marine and fresh-water organisms have frequently been exhibited at the Meetings of this Society. Last year, when very kindly sending me a beautiful slide of the ova of *Portunus*, Mr. Waddington at the same time furnished me with a very interesting account of his own observations on the subject, which confirmed in all points my own experience. Mr. Waddington, in his letter to me, also states that he referred the matter to Dr. H. C. Williamson, of the Fishery Board of Scotland, who was able to confirm the fact that one impregnation of the female crab is sufficient for the fertilization of two or three depositions of ova.

In illustration of this interesting phenomena, I have pleasure in showing to-night under the Microscope the preparation of ova from a second deposition sent me by Mr. Waddington, and a series of photomicrographs which I have made from my own material.

SUMMARY OF CURRENT RESEARCHES

RELATING TO

ZOOLOGY AND BOTANY

(PRINCIPALLY INVERTEBRATA AND CRYPTOGAMIA),

MICROSCOPY, ETC.*

ZOOLOGY.

VERTEBRATA.

a. Embryology.†

Experimental Embryology.‡—The late J. W. Jenkinson delivered three lectures introductory to Experimental Embryology, which have now been published. The first discusses growth, the structure of the germ-cells, and fertilization. "When the germ-cells meet and unite in the act of fertilization the full number of chromosomes ($2n$) is restored, but that is not the only nor even the chief event involved in the process. In fertilization four distinct events occur, and sometimes a fifth. The first of these is the extrusion by the ovum of a fluid, the perivitelline fluid; the second is the entrance of the spermatozoon; the third is the appearance of the definitive centrosome and its division into two to form the cleavage apparatus of asters and spindle; the fourth is the union of the male and female pronuclei. To these must be added, in some cases at least, a fifth, the alteration of the structure and symmetry of the egg."

The second lecture discusses four problems. The first of these is to discover why the egg divides at all. The second is to find out why, when it does divide, it exhibits its own particular pattern of cleavage. The third inquires into the causes which bring segmentation to an end. The fourth question asks whether cleavage is or is not in itself a process of differentiation, the answer being in the negative, for it is held that

* The Society are not intended to be denoted by the editorial "we," and they do not hold themselves responsible for the views of the authors of the papers noted, nor for any claim to novelty or otherwise made by them. The object of this part of the Journal is to present a summary of the papers *as actually published*, and to describe and illustrate Instruments, Apparatus, etc., which are either new or have not been previously described in this country.

† This section includes not only papers relating to Embryology properly so called, but also those dealing with Evolution, Development, Reproduction, and allied subjects.

‡ Three Lectures on Experimental Embryology (Oxford, 1917) xvi and 130 pp. (20 figs.).

the causes of differentiation reside in the first instance in specific organ-forming cytoplasmic materials.

The third lecture deals with differentiation. 1. "Experiment shows that the removal of certain parts of the cytoplasm of the ovum entails the absence or at least the defective development of certain organs of the embryo or larva. Hence there are in the cytoplasm certain material factors on which the formation of certain characters depends. These characters are part of the total inheritance. 2. Every visible substance in the cytoplasm is not, however, necessarily such an organ-forming substance, as experiments with the centrifuge demonstrate. 3. Experiments on heterogeneous hybridization indicate that it is the large characters—those of the phylum, class, order, family to which the animal belongs—that are carried by the cytoplasm, and, this means, transmitted through the female germ-cell alone. 4. At the same time the cytoplasm is, during prematuration stages, indebted to the nucleus for certain elements in its structure. In the female, therefore, these nuclear elements of the cytoplasm are concerned in the transmission of inheritable characters, as well as the chromosomes. 5. In the chromosomes the germ-cells of the two sexes are alike, and these chromosomes are certainly concerned in the transmission of some characters. 6. It is known (*a*) by observation, and (*b*) by experiment that there are qualitative differences between individual chromosomes, and that a complete set of these different chromosomes must be possessed by every cell in the body if development is to be normal. It is further probable that the chromosomes are heterogeneous. 7. The different activities of the different chromatic elements are probably only called forth by differences in their environment, that is, in the cytoplasm to which they are distributed. It is known that differential behaviour of nuclei can be incited by cytoplasmic dissimilarity. 8. Hybridization experiments on nearly related forms make it certain that smaller characters—generic, specific, varietal, and individual—can be transmitted as easily from the father as the mother, and therefore through the nuclei."

The volume ends with a discussion of the interaction of parts upon one another in development. Thus under certain conditions a lens may be formed over the optic vesicle from cells other than those that are usually devoted to its formation. The auditory vesicle may be transplanted into another individual and become surrounded by a capsule developed from connective tissue which would otherwise have had a very different fate. The directive stimulus of one part upon another is a factor of the utmost importance, and one that simplifies the whole process of development.

Sex of Tadpoles Reared from Artificially Parthenogenetic Ova.* J. Bronté Gatenby experimented with five thousand eggs of *Rana temporaria* smeared with blood and lymph and pricked with a fine glass needle under the usual precautions. He succeeded in raising about fifty tadpoles to the closure of the neural folds. Fifteen were brought on to the stage when the external gills become covered by the epidermal

* Quart. Journ. Micr. Sci., ii. (1917) pp. 213–16 (5 figs.).

overgrowth, but all died except two before the hind limbs broke through. One of the survivors died at the critical time when the germ-cells were beginning to be differentiated, but would apparently have been a male. The other grew to two and a half times the normal size, but just as the front limbs had appeared it jumped out of the water and died. When the gonads were sectioned, the tadpole was found to be a well-developed male.

Morphogenesis of Monsters.*—E. I. Werber has experimented with the eggs of *Fundulus heteroclitus*, subjecting them to the action of some substances which occur in metabolic toxæmia. Positive results were got particularly from butyric acid and acetone, which are produced in disturbances of carbohydrate metabolism. A great variety of monsters resulted, affecting the eyes (cyclopia, synophthalmia, monophthalmia asymmetrica, and anophthalmia), the ear vesicles (rudimentary development, presence of only one vesicle, synotia), the olfactory pits, the mouth, the central nervous system, the heart and blood-vessels, the fins, and the body form. Œdematous conditions were found in many embryos lacking a continuous system of blood circulation in various parts.

The chemically changed environment brings on blastolysis which destroys or disperses the germinal substance. The blastolysis may be chemical, altering (by solvent or precipitating or coagulating action) the germ's substance. This alteration results in dissociation or disintegration of parts of the substance (defect), or, occasionally, in a decrease in the germ's chemical capacity for development and differentiation (inhibition).

The blastolysis may also be osmotic, increasing the permeability and allowing sea-water to enter the eggs. The inhibition of sea-water by the eggs, which swell rapidly, calls forth a fragmentation of the germ and dispersion of parts which are still capable of further independent development and differentiation.

Almost all eye terata are due, not to inhibition, but to a defect, viz. to blastolytic elimination of a fragment of either ophthalmoblastic or potential inter-ocular material. Only such cases of anophthalmia, where on microscopic examination rudiments (ill-differentiated optic vesicles or cups) are found, form an exception to this rule. Here an inhibition is assumed, due to a decrease of the chemical capacity for development (chemical exhaustion).

The frequent occurrence of ophthalmic and anterior terata is ascribed to a higher degree of susceptibility in the earliest embryonic primordium, which eventually becomes the embryo's anterior end (animal pole). This is suggested by Child's discovery of a definite susceptibility gradient.

The numerous meroplasts recorded, especially such teratomata as the "solitary eye" and the "isolated eye," point to a very high degree of capability of parts of the embryonic primordium for independent development and differentiation (the "self-differentiation" of Roux).

* Journ. Exper. Zool., xxi. (1916) pp. 485–582 (3 pls.).

The occurrence of various duplicities would seem to point to a relatively high prospective potency of parts of the Teleost egg, but it decreases rapidly, for at an early stage (the Randwulst-stage or thereabout) these parts are already specifically predetermined as early (undifferentiated) primordia of some organs. If at this stage a fragment be eliminated the result will be a defect of a corresponding organ or part of the body. Accordingly the teratogenetic time limit must be regarded as very brief, and especially so in the case of duplicities.

The experiments tend to justify the hypothesis on which they were based, that parental metabolic toxæmia may be the cause, or, at least, the chief cause underlying the origin of monsters.

Early Development of Spleen in Lepidosiren and Protopterus.* G. L. Purser has studied the early development of the spleen in Lepidosiren and Protopterus. The spleen arises in a thickening of the mesenchyme of the foregut, just after the mesenchyme has become free from yolk-granules. It is, at first, a mass of mesenchyme cells round about which are large venous sinuses without any endothelial walls; later the cells become arranged to form trabeculæ across these sinuses, which thus get broken up into the channels of a sponge-work. The afferent and efferent veins are in very close connexion with the veins from the intestine and to the liver respectively. The arterial supply of blood develops from the cœliac artery rather later. The organ remains throughout ontogeny embedded in the sheath of the foregut, and is therefore inconspicuous.

Influence of Age on Sex.†—R. J. Ewart discusses the influence of the age of the grandparent at the birth of the parent on the number of children born and their sex. The imperfections of the data he has analysed are such that no very decided statements can be made. Still, some credence can be given to the belief that those born during the declining years of life do enjoy an enhanced fertility, which may, however, by the time at which birth occurs, be actually neutralized by the low survival value of their offspring.

The evidence presented suggests that the pre-natal mortality affects males more than females, that infant and pre-natal mortality are highly correlated, that infant mortality is higher in the case of elderly parturients and also in the case of parturients who are themselves the offspring of elderly parents, and that the differential pre-natal rate increases as age increases. If so, it must follow that the ratio of male to female births should diminish with the age of the parents. But the author's direct investigation of this point leads, if anywhere, to an opposite conclusion. "Hence it must follow that age exerts a direct polarizing influence upon the sexual cell (whether before or after fertilization cannot even be conjectured) sufficient to neutralize the factors which make for the production of an excess of females."

* Quart. Journ. Micr. Sci., ii. (1917) pp. 231–41 (3 pls.).
† Journ. Hygiene, xv. (1915) pp. 127–62 (1 fig.).

Action of Corpus Luteum.*—M. Itagaki finds that extract of corpus luteum generally produces a distinct increase of tone in the plain muscle of the uterus of rat, rabbit, cat, dog, and guinea-pig. Rarely, however, the opposite effect is produced. It would appear that there are two principles in the corpus luteum having an antagonistic action upon the contractions of the uterus. These principles can be separated by alcohol, the inhibitory or chalonic material, which is generally very small in amount, going into alcoholic solution. The hormonic substance, which is generally much larger in amount, is soluble in water, but not in alcohol, nor in chloroform and ether.

Occurrence of Spermine.†—Mary Christine Rosenheim points out that, in spite of the results of Schreiner and Poehl, the assertion is often made that spermine is confined to the sperm and the secretion of the prostate. She finds that spermine is not confined to the male sex, nor, indeed, to the animal kingdom. She has isolated it from testis, pancreas, spleen, brain, cancerous lymphatic tissue, cod's ovary, yeast, etc. All the evidence obtained up till now points to the view that spermine has the constitution of a relatively simple aliphatic base.

Chemical Composition of Ovaries.‡—Yasaburo Taniguchi finds in the corpora lutea of the cow's ovaries ten different ferments, and almost the same in ovaries freed from corpora lutea.

Life of Spermatozoa of Horse outside of the Body.§—Shigeo Satô has observed the duration of life of horse spermatozoa in 1·1 NaCl. solution (up to ten hours, rarely twenty-four), and in 5·2 to 5·25 p.c. dextrose solution (ten to thirty hours, rarely seventy). An alkalinity the same as 0·001 p.c. KOH is most suitable ; the optimum osmotic pressure is that equal to 5·24 p.c. dextrose ; the suitable temperature is about 13° to 15° C. ; one atmosphere pressure is best ; the suitable percentage of oxygen is much less than that in air.

Life of Spermatozoa in Solution.‖—Shin-Itsu Ochi finds that the spermatozoa of the white rat from well-fed and well-developed animals can live well for a time in a 3·3 p.c. dextrose solution, or a mixture of 0·7 p.c. salt solution and dextrose. The solution should be slightly alkaline ; acidity is injurious ; the optimum temperature is 22·5° C. ; sunlight is injurious ; so is change in the atmospheric pressure.

Sex Dimorphism in Sardine of Algerian Coasts.¶—J. P. Bounhiol calls attention to the fact that the males of *Alosa sardina* are always much smaller than females of the same age, as estimated by scale-

* Quart. Journ. Exper. Physiol., xi. (1917) pp. 1–25.
† Proc. Physiol. Soc., in Journ. of Physiology, li. (1917) Nos. 1–2, pp. vi–vii.
‡ Acta Scholæ Med. Univ. Imp. Kioto, i. (1916) pp. 299–339.
§ Acta Scholæ Med. Univ. Imp. Kioto, i. (1916) pp. 361–74.
‖ Acta Scholæ Med. Univ. Imp. Kioto, i. (1916) pp. 341–9.
¶ C.R. Soc. Biol. Paris, lxxx. (1917) pp. 77–80 (1 fig.).

markings and other structural features. The inequality increases rapidly to the end of the first year, when it reaches its maximum. Thereafter it diminishes, but never disappears.

b. Histology.

Visible Structure of Cell Protoplasm and its Death Changes.*— Robert Chambers, jun., has studied in particular the ova of *Asterias*, *Arbacia*, *Echinachnius*, *Cerabratulus*, and *Fucus*. His methods are those of "microdissection." "It is remarkable how much tearing and pulling with a needle living protoplasm will undergo without showing injury. One may puncture a cell with a needle, and drag the needle through the cytoplasm back and forth, cutting through the sides of the cell, and if the procedure be slow and gradual the tear closes up behind as the needle proceeds, and the process may be continued almost *ad libitum* without producing an ill effect. If, on the other hand, the needle be carried rapidly through the cytoplasm, a few thrusts only are necessary to induce rapid disorganization. The effects of injury are probably cumulative. If injurious effects be made to follow one another without giving the cell time for recovery, the additive effects of the injury soon manifest themselves in disorganization of the protoplasm, resulting in the death of the cell."

The following conclusions have been arrived at in regard to the fine structure of the protoplasm. Protoplasm is a hydrophilic colloid which, in early germ-cells, egg-cells, and Protozoa, usually exists in the sol state, with a surface layer in the gel state. Adult somatic cells generally are gels in which one cannot demonstrate a cell membrane possessing a consistency different from that of the cytoplasm within.

The microscopically-visible granules in the cytoplasm of the egg of *Arbacia* may be classified in two groups: (*a*) the microsomes, which are considerably less than one micron in diameter, and constitute the most resistant parts of the cell, maintaining themselves after its complete disorganization; and (*b*) the macrosomes, which range from 2–4 micra in diameter, and are very sensitive to injury.

The external surface of the egg-cell is a gel which passes gradually into the sol in the interior. The surface gel is very extensile and contractile and is readily regenerated on injury. Tearing of this surface, if unrepaired, results in an outpouring of the internal cytoplasm and in dissolution.

A remarkable property of protoplasm is its ability to form a protective gel film not only on its external surface, but also around an injured area which is in process of disorganization. The disorganized mass thus insulated is eventually expelled.

Disorganization of the cytoplasm of the egg-cells studied takes place in the following way:—(1) the macrosomes swell and go into solution; (2) the liquid hyaline cytoplasm may flow out into the water or form a rigid coagulated mass. The coagulation structure gradually coarsens

* Amer. Journ. Physiol., xliii. (1917) pp. 1–12 (2 figs.).

with the production of a network or granular precipitate. Injury is accompanied by a swelling and an apparent increase in the acid reaction of the part involved.

The comparatively rigid ectoplasm and the fluid endoplasm of Protozoa are directly comparable to the surface layer and the internal cytoplasm of the marine ova studied. The surface layer and the internal cytoplasm showed themselves equally permeable to the basic vital dyes used.

The germinal vesicle of an immature egg consists of a hyaline liquid enclosed in a gel-like membrane. The nucleolus is an immiscible droplet floating in the vesicle, and is very sensitive to mechanical injury. The contents of the germinal vesicle of a young ovum have a destructive effect on the cytoplasm. The cytoplasm of an immature egg is much less affected by tearing than is that of the mature egg. In the mature egg the nucleus behaves as a fluid droplet immiscible with the cytoplasm. It may be divided into two droplets, which unite on touching. It readily coagulates if mechanically injured.

Minute Structure of Nerve-Fibre of Fishes.*—Manuel Sánchez y Sánchez describes the elaborate trabecular and glomerular structures which form a supporting apparatus in the nerve-fibres.

Oxygen Pressure and Tissue Cultures.†—Montrose T. Burrows has experimented with parts of chick embryos. He finds that they grow in cultures somewhat better in spring and summer than in winter. It seems that cells may grow in an atmosphere of pure oxygen, but their growth, although often slightly more rapid, is not greater in pure oxygen than in a partial pressure of oxygen no more than 9 or 10 p.c. The growth becomes less when the partial pressure of oxygen is lower than 9 or 10 p.c., but very evident growth activity is seen in an atmosphere where the partial pressure of the oxygen is as low as 45·6 mm. Hg. The general results show that the activity of the cells in the cultures is little influenced by changes in the oxygen concentration or partial pressure when that remains above a certain amount.

Structure of Penis in Hedgehog.‡—Ed. Retterer and H. Neuville give a detailed account of the minute structure of this organ. Reaching the glans, the corpora cavernosa and the corpora spongiosa form a median and superior languette at the end of which the urethra opens. The rest of the glans is due to a swelling and vascularization of the fascia penis and of the cutaneous investment. There are voluminous venous plexuses. A thick and long frenum binds the inferior surface of the base of the glans to the prepuce. The urethral epithelium is stratified and pavement-like, but when heat sets it it tends to become stratified and cylindrical.

* Bull. Soc. Españ. Hist. Nat., xvi. (1916) pp. 467–70 (2 figs.).
† Amer. Journ. Physiol., xliii. (1917) pp. 13–21.
‡ C.R. Soc. Biol. Paris, lxxx. (1917) pp. 83–6.

c. General.

Marine Plankton around South End of Isle of Man.*—W. A. Herdman, Andrew Scott, and H. Mabel Lewis refer briefly to the intensive study of the plankton of a small area near the centre of the Irish Sea. The study has been continued for ten years, and 5116 samples have been taken, of which 496 were in 1916. The spring maximum for the total plankton in 1916 was in June, a month later than in 1915 and several previous years. The maxima of the leading groups succeeded one another in the usual order, as follows:—In May, the Diatom maximum; in July, the Dinoflagellate maximum; in September, the Copepod maximum. The monthly average number of Dinoflagellates for July was 148,241; the actual largest number was 316,400 on July 6, of which 300,000 were *Ceratium tripos*. The monthly average number of Copepods for September was 57,616, and the largest haul yielded 118,524 on September 25.

Increase of Erythrocytes after Exposure to Carbonic Acid.†—Dorothy Dufton exposed rabbits to atmospheres containing an unusually high percentage of carbonic acid in the air, and observed in a few days (six) a marked increase in the number of erythrocytes. In whatever way the carbonic acid may act, which requires further investigation, the results suggest that any factor, such as violent exercise, which produces a temporary rise in the concentration of carbonic acid in the blood, will produce a corresponding formation of fresh corpuscles.

Experiments in Regard to the Pituitary Body.‡—W. Blair Bell finds that the removal of the pituitary body in dogs causes death in a few hours. It is the removal of the anterior part which is particularly fatal. Partial removal of this part may cause genital atrophy. Neither partial nor complete removal of the posterior part causes any symptom. The secretion of the pars nervosa is neither necessarily beneficial nor essential to life. Clamping and separation of the infundibular stalk, by interfering with the blood-supply and so causing degeneration in the cells of the partes anterior and intermedia, lead to the condition known as dystrophia adiposo-genitalis. The pituitary body appears to be one organ and not two; and the essential and beneficial secretion is taken up by the blood-stream, as in the case of the other organs of internal secretion.

Effect of Thyroid on Suprarenals.§—P. T. Herring finds that small quantities (0·2–0·5 grm.) of fresh ox-thyroid administered daily to white rats increases the size and weight of the suprarenals both in young and adult animals. In three or four weeks there was an increase in weight of from 76 to 78 p.c. above the normal. Both cortex and

* Report Lancashire Sea Fisheries' Laboratory, No. 25 (1917) pp. 28–30.
† Proc. Physiol. Soc., in Journal of Physiology, li. (1917) Nos. 1–2, pp. v–vi.
‡ Quart. Journ. Exper. Physiol., xi. (1917) pp. 77–126 (57 figs.).
§ Quart. Journ. Exper. Physiol., xi. (1917) pp. 47–57.

medulla participate in the enlargement, but the hypertrophy of the cortex is somewhat greater than that of the medulla. The adrenalin content increases. The rats not infrequently die suddenly while apparently thriving. This is due to rapid cardiac hypertrophy.

Variation of Common Lizard.*—G. A. Boulenger gives an account of the great variability in the scales (lepidosis) and coloration of *Lacerta vivipara*; and notes that it is highly remarkable that a species which has such a wide distribution, and lives under such varied conditions of climate and soil, should show no definable geographical races. The variations recorded are purely individual. The species is the most widely-distributed member of the genus, and probably one of the most ancient. Boulenger regards it as derived from *L. agilis*, and as leading to the Oriental genus *Tachydromus*. So far as is known at present it is the only species of Lacertidæ which can be called viviparous.

INVERTEBRATA.

Mollusca.

α. Cephalopoda.

Sensory Reactions of Cuttlefish.†—Marie Goldsmith has made a number of interesting experiments on cuttlefishes. She proves their capacity for distinguishing colours. Red is no exception and can be distinguished from black. Associations can be established between the colour of an object and its edibility, even when neither the colour nor the object is part of the animal's normal environment. These associations permit of the establishment of memory, which is, however, of short range. The power of remembering is facilitated by repetition, and it disappears gradually. Recollection of tactile impressions seems to last longer (eight hours) than that of visual impressions (three hours).

Arthropoda.

α. Insecta.

Stem-inhabiting Ants in Switzerland.‡—Rob. Stäger has made a study of species of *Leptothorax*, *Cremastogaster*, *Colobopsis*, *Dolichoderus* which nest in hollow stems of bramble. Some were found in branches of spruce, oak, *Rumex*, etc. The borings which the ants utilize are in many cases made by wasps and bees.

Development of Trichogramma evanescens Westw.§—J. B. Gatenby describes the embryonic development of *Trichogramma evanescens*, a parasitic member of the family Chalcididæ, a numerous and interesting

* Journ. Zool. Research, ii. (1917) pp. 1–16 (3 figs.).
† Comptes Rendus, clxiv. (1917) pp. 448–50.
‡ Revue Suisse Zool., xxv. (1917) pp. 95–109.
§ Quart. Journ. Micr. Sci., ii. (1917) pp. 149–87 (3 pls.).

assemblage of minute Hymenoptera. It lays its egg on the egg-mass of a beetle, *Donacia simplex*, a single parasite emerging from one egg of the host. The ovum has a large germ-cell determinant at its posterior pole, and in segmentation the determinant is divided among the large cells in that area. These are the germ-cells. In the single case found there were two polar bodies. The blastula is fairly normal, except for a curious arrangement of the chromatin in the somatic nuclei. Many nucleoli are cast out into the centre of the egg, where they collect till twenty-five to fifty are present; the mass is then extruded on the periphery of the egg. As the blastoderm grows it broadens without lengthening up to the stage where the germ-layers begin to form. About thirty-five nuclei sink inwards from the dorsal surface of the embryo to form endoderm. From the blastoderm stage to that of the gastrula no nuclear division appears to take place. Shortly after the formation of the endoderm amitosis may be found, and from this onwards the number of nuclei increases. The mesoderm seems to be formed from peripheral nuclei which sink in sporadically; no somites can be made out, nor does any segmental method of formation of the mesoderm occur. The nervous system, stomodæum and probably proctodæum are normally formed. The germ-cells lie in a pocket formed by several somatic cells which embrace them. Ordinary mouth-parts, tracheæ, heart, and œsophageal valve are wanting; the head has two horn-like mandibular processes, which may assist in scooping forwards the food. The larvæ does not feed on the food little by little, defecating as it eats; instead, it begins by swallowing all the yolk at once, so that its body becomes enormously distended and stretched. Metameric external segmentation is absent, the body and head being continuous and sac-like.

Black Markings on Wings of Large Cabbage Butterfly.*—Herbert Onslow finds that the black markings on the wings of *Pieris brassicæ* are caused by the oxidation of a colourless chromogen by a tyrosinase. This ferment is supplied from the body-lymph of the pupa, possibly by means of the wing-nervures, to the chromogen which has previously been deposited in the areas destined to become black. The form of the markings is determined by the localization of the chromogen to these areas. The oxidation takes place just before the emergence of the fully-developed insect, and as soon as the atmospheric oxygen has access to the surface of the wing.

Aquatic Lepidoptera.†—Welch finds that eggs of *Nymphula maculalis* are invariably deposited about the egg-holes of a Chrysomelid beetle (*Donacia*) in the floating leaves of the yellow water-lily. Tracheal gills appear in the second instar. There are forty filaments in the second instar, over four hundred in the full-grown larva. Excised pieces of leaves form a case, serving for protection and support in the water.

* Biochemical Journ., x. (1916) pp. 26–30.

† Ann. Entomol. Soc. Amer., ix. (1916) pp. 159–90. See also Trans. Amer. Micr. Soc., xxxv. (1916) p. 261.

The larvæ crawl about, or are distributed passively. The larvæ and pupæ usually pass their whole existence under water; the adults are aerial and nocturnal. The eggs of *N. iccuisalis* are laid on the margins of the leaves of *Potamogeton natans*; there are no tracheal gills; cases are made as in the other species.

Intersex of Amorpha populi.*—E. A. Cockayne describes a specimen of *Amorpha populi* in which, although head, thorax, and wings appeared to be male, the abdomen was full and rounded like that of a female. Dissection showed that both external and internal reproductive organs were male, but with many abnormalties, which are described in detail. The interest of the specimen lies in the fact that it resembles closely the Lymantrias derived from crossing to which Goldschmidt gave the name "intersex," to distinguish them from ordinary halved gynandromorphs, which must arise from a different cause. The form examined also arose from crossing various races of British *A. populi* for several generations.

Cocoon Colour in Lepidoptera.†—O. A. Merritt Hawkes has studied the cocoon of *Plusia moneta* and other Lepidoptera with a view to elucidating the factors determining changes in cocoon-colour. The subject is almost untouched ground, but certain factors in the production of white cocoons are suggested provisionally. These are:—1. The absence of an intestinal fluid (i.e. either an excretion from the intestine or the secretion of the Malpighian tubules). 2. A comparatively dry environment. 3. A lack of foreign particles. 4. A reduction of an original yellow colour. Examples are given in illustration of each of these factors, and the author believes that further investigation will probably co-ordinate the effect upon white silk of intestinal fluids and atmospheric moisture.

Rein-sheath in Plebeiid Blue Butterflies.‡—T. A. Chapman adds a note to a previous paper on the pairing of Plebeiid Blue Butterflies, to correct a statement in regard to the rein-sheath. He finds that this remarkable structure is made of scales, but scales of a very unusual nature. The end, by which each was presumably attached to the rein, tapers to a very small point, less like the usual socket of a scale than like the traces of abortive hairs or scales. The body of the scales is curled or twisted, and the curlings or twistings are so intertwined as to hold the scales together to form a cylinder. The female butterfly possesses this cylinder on emerging from the pupa, but loses it as soon as pairing is over. The special character of the furca in the floor of the male genital cavity is probably related to the rein and its sheath. The investigator has verified the presence of the sheath in seven species, and believes that it will be found to occur, with differences of detail in structure, in all the Blue Plebeiids.

* Trans. Entomol. Soc. London, iii.–iv. (1916, publ. 1917) pp. 343–4 (1 pl.).
† Trans. Entomol. Soc. London, iii.–iv. (1916, publ. 1917) pp. 404–11.
‡ Trans. Entomol. Soc. London, iii.–iv. (1916, publ. 1917) pp. 297–300 (2 pls.).

Alimentary Canal of Cetoninæ.*—L. Bordas has studied the structure of these beetles, which are included in the group without a gizzard or with no more than a much reduced gizzard. A positive character in *Cetonia* is the great development of the mid-gut which forms two-thirds of the total length. It is marked by numerous superficial papilliform glandular diverticula which compensate for the absence of salivary glands. The four moniliform and varicose Malpighian tubes are filled with crystals of calcium urate. Some other types (*Oxythyrea*, *Trichius*, *Tropinota*) are similarly dealt with.

Reflex "Bleeding."†—McIndoo finds that the ejection of fluid from the femoro-tibial articulations in the Coccinellid beetle, *Epilachna borealis*, is a true reflex, but that the fluid is not blood. It is due to hypoderm glands, the secretion of which issues by numerous pores near and in the articular membrane. There are also pores of another kind on the membrane. The secretion is bitter and disagreeable, probably protective, perhaps associated with sex recognition and with distinguishing between different individuals.

Life-history of Agriotes obscurus.‡—George H. Ford gives an account of the larval and pupal stages of the Elater, *Agriotes obscurus*, whose larvæ, along with certain related forms, are called "wireworms." The life of the larva is probably four, rather five years. The larva of *A. obscurus* can be distinguished from that of *A. lineatus* by the blunt tooth below the apex of the mandible being more prominent, by the orderly arrangement of the body hairs, and the more anterior position of the stigmata. Moreover the anal papilla on the ninth abdominal segment of *A. obscurus* has two apical divisions, while that of *A. lineatus* has three. Lapwings and moles eat large numbers of the larvæ. The larva pupates in an earthen cell in the ground, down to one foot deep. The pupal period is about three weeks. The imago remains motionless in the pupal cell for roughly two months, after which it comes to the surface and hibernates under stones, clods, etc., until the next season.

Study of Tipula paludosa.§—John Rennie has studied the life and habits of this common crane-fly. A newly hatched female contains considerably over 400 shelled ova. The egg measures 1·1 mm. by 0·4 mm., and is black in colour with a dark purplish metallic lustre. The larvæ emerge in about fourteen days after the eggs have been laid. They are then of a pale reddish sandy colour, about 2·7 mm. in length. Their features are described. The full-grown larva is about 40 mm. in length. The mouth-parts and the stigmatic area are carefully described and figured. The newly hatched larvæ die off quickly in dry soil and in sunlight. Their feeding habits are discussed in detail.

* Bull. Soc. Zool. France, xlii. (1917) pp. 7–12 (3 figs.).

† Ann. Entomol. Soc. Amer., ix. (1916) pp. 201–22. See also Trans. Amer. Micr. Soc., xxxv. (1916) p. 267.

‡ Ann. Applied Biol., iii. (1917) pp. 97–115 (2 pls.).

§ Ann. Applied Biol., iii. (1917) pp. 116–37 (3 pls. and 3 figs.).

Characters of Dipterous Larvæ.*—John R. Malloch has done a useful piece of work in studying the larval and pupal characters of North American Diptera, a synoptic account of which has been wanted for a long time. What he has done (only Part I is published) will enable students to identify many larval forms. The material is also utilized in reference to the classification of the imagines. The author presents a vast amount of information in effective form, and his analytical keys are very valuable.

Early Development of Horse Bot-fly.†—E. Roubaud discusses the various theories as to the early chapters in the development of *Gastrophilus equi*. Some say that the larvæ hatched on the skin enter the mouth and nostrils of themselves; others say that they are licked in by the horse's tongue; and others that they penetrate the epidermis and are ingested when the horse bites at its irritated skin.

Roubaud's observations lead him to the following conclusions:— 1. The eggs do not hatch spontaneously; they may remain for some weeks in a passive state on the skin. 2. The ripe egg liberates the larva when touched; licking is not essential. 3. The primary larvæ, liberated when touched with the mucous membrane of the lips or gums, insinuate themselves horizontally below the epithelium. 4. The primary larvæ do not perforate the skin; their mouth-parts are not suited for this. 5. The primary larvæ move and grow in the mucosa of the mouth, working from near the surface to deeper parts. After the first moult they leave the epithelium and pass down to the stomach. A somewhat similar life-history seems to occur in *Gyrostigma* (*Spathicera*) of the rhinoceros. As to the bots observed in cutaneous wrinkles in man (rampant myasis), Roubaud believes that the larvæ enter by the external mucous membrane of eyelids or lips, or by a cutaneous lesion. They are not able to perforate the skin directly.

Phylloxera Galls.‡—Rosen finds that the leaf-gall produced on *Vitis vulpina* by *Phylloxera vastatrix* begins on the bud leaves, and produces a depression due to the upward growth of tissue at the sides. There is no evidence of stimulus due to some chemical substance; the initial stimulus is the continuous sucking action of the insect at a single fixed point.

Pure Lines in Aphides.§—Ewing finds no summation effect of selection in reference to six fluctuations of *Aphis avenæ*. The fluctuations do not seem to be germinal. Changes in body-length were found

* Bull. Illinois State Lab. Nat. Hist., xii. (1917) pp. 161–409 (30 pls.).
† Comptes Rendus, clxiv. (1917) pp. 453–6.
‡ Amer. Journ. Bot., iii. (1916) pp. 337–60. See also Trans. Amer. Micr. Soc., xxxv. (1916) pp. 258–9.
§ Biol. Bulletin, xxxi. (1916) pp. 53–112. See also Trans. Amer. Micr. Soc., xxxv. (1916) pp. 256–7.

to be mainly due to changes in temperature and food. The rarely-appearing discontinuous variations were apparently not inherited.

Brain of Termites.*—Thompson finds that the structure of the brain in termites is very like that in ants, except that the mushroom-shaped bodies are much simpler and more primitive. No sex differentiation occurs between the brains of the different castes or stages, and but little caste differentiation appears, although the optic apparatus shows a correlation between the degree of development of the compound eyes and the size of the optic lobes. Simple ocelli are present in the nymphs and adults of the sexual forms, absent in the worker and soldier. The problematical frontal gland, which seems to be functional only in the true adults and soldiers, may be derived from the ancestral median ocellus.

Growth and Habits of Stick Insect.†—H. Ling Roth has made a study of the growth and habits of the stick insect, *Carausius morosus* Br., as a contribution towards a knowledge of variation in an organism which reproduces parthenogenetically. The observations were made in a regulated temperature from 56°–64° F. The insects, which are lethargic in habit, vary in colour from light fawn to dark green. Occasional very dark brown examples occur. During life the colour barely changes. Incubation in boxes varied from 137–297 days. The insects were parthenogenetic; only one, obviously an infirm female, failed to produce eggs. One male was found, but it had no contact with any of the females under observation. The average length of egg-capsule was 2·8 mm. Under 2·6 mm. they did not hatch out. The fertility of the eggs was 81·5 p.c. Eggs are dropped on an average 16·5 days after the last ecdysis. The average egg-production was 513 per insect, the highest total reached by one insect being 712. No correlation could be found between the length of the insect and the number of eggs. The length of the nymphs on hatching averaged 10·5 mm., and in twenty-one days they had increased 3–5 mm. This is the only period during which they grow without moulting. The nymphs fast from 2–6 days before the actual moult. The ecdyses were performed by the nymph hanging head downwards, the skin splitting from the pronotum upwards, when gravity did the rest. There were six ecdyses in each case, and the increase in length each time was very marked. The body-length increased six-fold; the antennæ increased in the same total ratio, but there were differences of increase in the various segments. The progeny from eggs dropped late in life attained a greater length than that from eggs dropped early. The insect spends two-fifths of its life in the preparatory period (to the sixth moult), and the remaining three-fifths in the reproductive period.

The author's results bear out the observations of Warren rather than those of Weismann. Summaries of the variations noted are given in tabular form.

* Journ. Compar. Neurology, xxvi. (1916) pp. 553–603. See also Trans. Amer. Micr. Soc., xxxv. (1916) pp. 266–7.

† Trans. Entomol. Soc. London, iii.–iv. (1916, publ. 1917) pp. 345–86.

British Collembola.*—John W. Shoebotham gives a translation of Börner's classification of the Collembola and a useful list of the 44 British genera, including *Willowsia* g. n., allied to *Sira*.

β. Myriopoda.

Structure of Cylindroiulus nitidus.†—Hilda K. Brade and S. Graham Birks describe the external features of this millipede found near Leek, Staffordshire. An account is given of colour-markings, appendages, ocelli, and male gonopods. As Verhoeff has pointed out, the ocelli are of great interest, representing a condition intermediate between *Ommatoiulus* and *Allaiulus*. The external surface of the field of the eye is quite smooth, not broken up by the convexities of the individual ocelli. There is great variation in the number of ocelli. The structure of the male gonopods is described and figured in detail.

ε. Crustacea.

Mouth-parts of Prawns.‡—L. A. Borradaile gives an account of the mouth-parts of Palæmonid prawns, such as the common *Leander serratus*. He regards the primitive crustacean limb as consisting of a flattened axis with a flabellum (exopodite), two or more epipodites, a series of eight endites and an apical lobe, the flabellum standing opposite the third and fourth endites. The relations of the various mouth-parts to this prototype are discussed. Particles of food seized by the chelipeds are generally received by the second maxillipedes which hold it in place while pieces are torn off it by deeper lying organs, probably in the main by the incisor processes. The maxillules may also receive food from the chelipeds. In handling bulky masses the third maxillipedes may assist the chelipeds or the second maxillipedes. The second maxillipedes seem to be indispensable, and their movements are described. The first maxillipedes and the maxillæ probably take no very prominent part in manipulating the food. The exopodites of the maxillipedes set up a strong forward current which carries away exhausted water and also the waste products of the green glands. But the current has also a significance in the feeding process. From time to time particles are rejected by the second maxillipedes, which kick them violently forwards, the distal parts of the third maxillipedes at the same time straightening so as to admit them to the outgoing stream, by which they are swept away.

Terrestrial Isopods from Chilka Lake.§—Chas. Chilton describes *Ligia exotica*, a maritime species usually found near the sea-shore, which has adjusted itself to more purely terrestrial conditions on the shore of Chilka Lake. The appendages are figured, and the young from the incubatory pouch. The outer branch of the first pleopod of the male is

* Ann. Mag. Nat. Hist, xix. (1917) pp. 425–36.
† Ann. Nat. Hist., xix. (1917) pp. 417–24 (8 figs.).
‡ Proc. Zool. Soc. London, 1917, pp. 37–71 (51 figs.).
§ Mem. Indian Museum, v. (1916) pp. 461–82 (36 figs.).

very large, and its surface shows a branching structure, presumably of blood-vessels. Three other species are dealt with—*Alloniscus pigmentatus*, *Hemiporcellio carinatus*, and *Cubaris granulatus*.

Isopod from Guacharo Cave, Trinidad.*—W. E. Collinge describes *Calycuoniscus spinosus* sp. n., from the guano of a cave in Trinidad called the Guacharo Cave. The cave is tenanted by the Oil-bird or Guacharo (*Steatornis steatornis*). From the nests of the bird specimens were procured of *Calycuoniscus bodkini* Cllge, previously obtained from beneath the bark of trees in British Guiana. The new species differs in possessing a smaller number of the peculiar chitinous cup-shaped organs on the segments of the body, and they are also more elongated; in the form of the cephalic lobes, which are exceedingly small; and in other quantitative characters.

Cladocera from Victoria Nyanza.†—Th. Delachaux reports on a collection from this region, from the lake itself (thirteen species), and from a stream near Bukoba (seven species). The list adds to Daday's previous list for Victoria Nyanza the following species:—*Macrothrix laticornis* (Jurine), *Alona poppei* Rich., *Chydorus barroisi* Richard, and *Monospilus dispar* G. O. Sars. There are no new species to describe, but the author communicates some notes and adds some distinctive figures. There is interest also in the geographical distribution.

Annulata.

Australian Polychæta.‡—W. B. Benham continues his report on the Polychæta collected by the Fishing Industries' ship "Endeavour." He deals with fourteen additional species, of which six appear to be new. Apart from five widely-distributed species, the relation of the Australian Polychæt fauna is with that of the Pacific. Its difference from that of New Zealand is very marked. The new forms include *Cheilonereis peristomialis* g. et sp. n., in which the peristomium is produced laterally and ventrally to form a large, widely extending, collar-like lip, and the base of the notopodium is raised into a lamelliform expansion exceeding in height the rest of the parapodium throughout the greater part of the body. The occurrence of *Priapulus caudatus* in Australian waters is noted.§

Australian Polychætes.‖—F. Fauvel deals with a collection of Polychætes from the Adelaide Museum, numbering fifty species in thirty-two genera. The only new species is *Ophelia ashworthii*, remarkable for

* Journ. Zool. Research, ii. (1917) pp. 29–30 (3 figs.).
† Rev. Suisse Zool., xxv. (1917) pp. 77–93 (21 figs.).
‡ Biol. Results Fishing Experiments, Commonwealth of Australia, iv. pt. ii. (1916) pp. 127–62 (3 pls.).
§ Biol. Results Fishing Experiments, Commonwealth of Australia, iv. pt. iii. (1916), not paginated.
‖ Arch. Zool. Expér., lvi. (1917) pp. 159–277 (5 pls. and 29 figs.).

its bifid branchiæ. Gaps in previous descriptions of a number of Aphroditidæ are now filled up. The collection confirms the author's view that Polychætes cannot be satisfactorily referred to zoological provinces. Temperature is the main factor in determining their distribution.

Nematohelminthes.

Notes on Nematodes.*—N. A. Cobb continues his contributions to "a science of nematology." He finds hints of segmentation in the disposition of the setæ. Some of the cephalic setæ are jointed, and are compared to segmented appendages. This is illustrated in reference to *Pomponema mirabile* g. et sp. n., *Scaptrella cincta* g. et sp. n., and *Chironchus vorax* g. et sp. n., three remarkable free-living marine types. In a species of *Selachinema* the "dorsal jaw" is vestigial, so that the two projecting "mandibles" become practically lateral, and the trilateral symmetry of the Nematode head is changed to bilateral.

On the beach-sand between tide-marks at Wood's Hole it was calculated that in one area there were on the top three inches of sand at least 527 millions of Nematodes per acre. On another beach there were at least 1040 millions per acre in the topmost inch of sand. On muddy shores the Nematode population is much more dense—thousands of millions per acre.

A new "locational" nomenclature is suggested for the varied relations of sexual reproduction and of the intracellular elements. Thus we have syngonic, digonic, amphigonic, homogonic, etc.; syncystic, dicystic, amphicystic, homocystic, etc.

New Ascarid of the Frog.†—L. G. Seurat describes *Porrocæcum numidicum* sp. n. from the duodenum of *Rana ridibunda*. In the shape of its buccal lips, in the disposition of the caudal alæ and of the genital papillæ of the male, it is near *Orneoascaris chrysanthemoides* Skrjabin, from the intestine of an East African species of *Bufo*, but it has much smaller spinules and a dorsal intestinal cæcum. It is quite distinct from *Ascaris brevicauda* of the newt.

New Acanthocephala from Birds.‡—H. J. Van Cleave has found in the Collections of the U.S. Bureau of Animal Industry four new Acanthocephala from birds—one belonging to the genus *Centrorhynchus* and three with characters which exclude them from any known genus, and warrant a new genus, *Mediorhynchus*. The two genera agree in the way in which the proboscis receptacle finds the insertion near the middle of the proboscis wall, and in their occurrence within the alimentary canal of birds. They differ in the size, shape, and number of the cement glands of the male; in the structure of the wall of the proboscis

* Notes on Nematodes. Baltimore: Waverly Press, 1917, pp. 117–28 (7 figs.).
† C.R. Soc. Biol. Paris, lxxx. (1917) pp. 94–7 (2 figs.).
‡ Trans. Amer. Micr. Soc., xxxv. (1916) pp. 221–32 (3 pls.).

receptacle; and in the relations of the invertors of the proboscis to the proboscis receptacle. They may be included in a new family, Centrorhynchidæ, to the species of which a diagnostic key is given.

Nematodes in Insects.*—Merrill and Ford describe *Diplogaster labiata* sp. n. from the gut of an adult beetle, *Saperda tridentata*. The numbers were so large that the wall of the gut was ruptured, causing death. In the heads of termites, *Leucotermes lucifugus*, the investigators found *Diplogaster ærivora* sp. n., sometimes seventy-five in one host. The Nematode also occurred in the soil about infested termitaries.

Platyhelminthes.

Bladderworms in House Fly.†—John E. Gutberlet finds that the Cysticercoid stage of *Choanotænia infundibuliformis*, a tapeworm of chickens, occurs in *Musca domestica*. Flies fed on the tapeworm's ova developed the Cysticercoid; chickens fed on flies developed the tapeworm.

Structure of Duthiersia.‡—Frank E. Beddard gives an account of the scolex in two species of this genus of tapeworms. In *Duthiersia fimbriata* Diesing, from *Monitor niloticus*, the bothria open by a continuous antero-lateral groove only; the apical pit is at the extremity of the scolex; the excretory system forms an abundant network of small tubes. In *D. expansa* Perrier, from *Monitor bengalensis* and other Indian forms, the scolex is larger; the bothria open by a continuous antero-lateral groove and by a separate posteriorly-situated pore, being thus funnel-shaped; the apical pit is not present; the excretory system of the scolex is represented by a less abundant network of larger tubes. The author describes some minutiæ of the structure of the scolex.

Intermediate Host of Schistosomum mansoni.§—Juan Iturbe and Eudoro have investigated the life-cycle of this Trematode in Venezuela. They infected *Planorbis guadelupensis* with the miracidia, and observed the whole subsequent development. They also infected *Ampullaria luteostoma* and *Planorbis cultratus*, but these species do not seem to be very liable to infection in their natural habitat. Each sporocyst produces fifty rediæ, of elongated or ovular shape, with a widely open mouth and a rudimentary digestive system. The cercariæ are characterized by a strong tail which is bifurcated throughout its distal third. The mouth is larger than the acetabulum. The body is filled up by three pairs of round glands, and does not show any vestige of an alimentary canal. At the bottom of the oral orifice a cavity may be seen ending in a blind sac. There is no pharynx.

* Journ. Agric. Research, vi. (1916) pp. 115–27. See also Trans. Amer. Micr. Soc., xxxv. (1916) p. 262.
† Journ. Amer. Vet. Med. Assoc., 1916, pp. 218–37. See also Trans. Amer. Micr. Soc., xxxv. (1916) pp. 262–3.
‡ Proc. Zool. Soc. London, 1917, pp. 73–82 (5 figs.).
§ Ex. Acad. Med. Venezuela, 1917, pp. 1–8 (2 pls.).

Incertæ Sedis.

Early Tertiary Cheilostome Bryozoa.*—Ferdinand Canu and Ray S. Bassler give a synopsis of American Early Tertiary Cheilostome Bryozoa. "In the Bryozoa, as in other living beings, the form is only the result of a function ; therefore in the study of the morphological variations of the organs we now substitute that of their physiologic function. Our studies are therefore always directed toward the discovery of functions which modify the skeletal form."

"All the species which have the same larval form have the same lineage and belong necessarily to the same family ; therefore the family is characterized by the larval system. The ovicell in which the larva develops is necessarily in rapport with it, and a knowledge of its structure gives the essential characters for readily interpreting the physiological purpose of the morphological and skeletal variations." We have given the authors' words, but we do not clearly follow them.

"A really natural genus differs from another genus only in possessing a different function and in the different form of any skeletal part. The essential functions common to all Bryozoa without exception are :—

"1. Passage of eggs and escape of the larvæ (= rapport of the operculum and the ovicell).

"2. Hydrostatic system and extrusion of the polypide (=form of the aperture and rapport of the operculum with the compensatrix).

"3. Calcification and chitinisation (=nature of the skeleton and of the frontal considered as immediate deposits of the endocyst."

"The function of the avicularia and of the onychocellaria is not known, but it cannot be common to all Bryozoa, because many species are deprived of these structures." They cannot therefore furnish good generic characters, but they may be utilized in cases where they seem indispensable to the life of the zoarium. The authors describe many new genera and species.

Development of Cephalodiscus.†—J. D. F. Gilchrist gives an account of the development of the Cape *Cephalodiscus* (*C. gilchristi*, Ridewood). He notes some facts with regard to the formation of yolk-granules, the presence of yolk-nuclei, and the character of nucleus and nucleolus. The segmentation is holoblastic, equal, or markedly unequal, and apparently indeterminate. A blastula stage occurs. The blastula becomes solid by proliferation of cells at one end ; there is no invagination at this stage. The point of proliferation marks the posterior end, and the anterior end is distinguished by the elongation of its cells. All the outer cells become elongate and assume the character of columnar cells full of yolk. As these increase in number a small posterior invagination appears. The cellular character of the yolk columns disappears ; the yolk granules are used up, and an ectoderm consisting of many nuclei in a protoplasmic network with a basement of membrane is formed. Excretory

* U.S. Nat. Museum, Bull. No. 96 (1917) pp. 1–87 (6 pls.).
† Quart. Journ. Micr. Sci., ii. (1917) pp. 189–211 (3 pls.).

matter in the form of dark specks and elongate rods is formed during this process, and constitutes the characteristic pigment of the late embryos and larvæ. The ventral thickening of the ectoderm is found at an early stage. The endoderm appears under the ectoderm, first as a number of cells at the anterior end, and ultimately as a complete chain of cells extending over the inner yolk, except at the point of proliferation at the posterior end. The cells occupying the blastocele break down like the outer cells, and become a mass of yolk-granules, in which are scattered a number of nuclei with associated protoplasm. Some of these pass outwards to form the endoderm, some pass inwards to form vitellophags. A lumen is formed in the yolk-mass, and it becomes connected to the posterior involution, giving rise to a gastrula-like structure. The internal mass of yolk assumes the form of a number of yolk columns or pyramids. The posterior body-cavities arise by a number of cells from the yolk-mass forming a second layer under the endodermal layer. The yolk lumen increases in size, the yolk-granules becoming converted into a homogeneous substance. This takes place chiefly on the dorsal side, where the yolk-lumen becomes connected with the archenteron. The position and extent of the five body cavities in the larva are shown. The yolk in the larva is in the form of an elongate mass of granules and homogeneous matter lying on the floor of the archenteron. Changes are described in the larval nervous system, and the appearance of a posterior thickening and involution of the ectoderm below the yolk-mass is noted.

Phoronis ovalis.*—S. F. Harmer found that the eroded appearance of a shell of *Neptunea antiqua* was due to the fact that the substance of the shell was traversed by the burrows of boring animals, most of which belonged to a minute species of *Phoronis* corresponding closely with the *P. ovalis* of Strethill Wright, which has usually been regarded as the immature form of some other species. It is now shown to be a well-characterized adult form inhabiting burrows which it excavates in the shells of molluscs. It possesses in a high degree the faculty of regenerating the distal end, which is of common occurrence in the genus. Its gregarious habit is probably the result of its power of reproducing by transverse fission, a process which takes place repeatedly and profusely. There is reason to believe that a similar process occurs in certain other species which are found as colonies consisting of numerous individuals, though it is uncertain whether these have the power of reproducing by fission.

Echinoderma.

Permeability and Activation of Sea-Urchin Eggs.†—Ralph S. Lillie has experimented with the eggs of *Arbacia* with reference to the rate of entrance of water, when the eggs are fertilized or unfertilized. His previous work showed that in dilute sea-water fertilized eggs take up

* Quart. Journ. Micr. Sci., ii. (1917) pp. 115–48 (3 pls.).
† Amer. Journ. Physiol., xliii. (1917) pp. 43–57.

water by osmosis several times more rapidly than unfertilized eggs. This phenomenon seemed to him to indicate that the permeability of the egg-surface to water is decidedly increased by fertilization, and hence to confirm the view that a general increase of surface-permeability is an esssential factor in the activation-process. According to Loeb, however, the increased entrance of water after fertilization is due to the removal of the layer of viscous material, or "jelly," which normally invests the unfertilized egg, and disappears at fertilization.

Lillie's further experiments show (1) that the jelly is variable in freshly-shed eggs and absent in a good proportion; nevertheless the rate of swelling is remarkably uniform; the variability in the size of the eggs, after remaining several minutes in the dilute medium, appears no greater than in normal sea-water. (2) The jelly remains in a small proportion of fertilized eggs, yet all such eggs swell at the same rapid rate; no exceptional slowly-swelling eggs are found. (3) After washing until the jelly is completely removed, in most eggs the effect of fertilization on the rate of swelling is precisely the same as before. It is clear, therefore, that the increased rate of entrance of water into the egg after fertilization is not due to the removal of an external impeding layer of jelly, but must be referred to a change in the egg itself, and most probably to a change in the properties of the limiting protoplasmic layer or plasma-membrane which controls the osmotic exchange. Experiments show increased permeability.

If an initial increase of permeability is the critical process of the resting-egg—as apparently also in the analogous process of stimulation—it is clear that the condition of increased permeability cannot be permanent; a reverse change must follow, i.e. a return to the semi-permeable and polarized state of the plasma-membrane, if the egg is to remain alive; otherwise, diffusion-processes will soon cause the disintegration of the egg. There has to be a "corrective" surface-alteration. This recovery is to be regarded as the expression of a synthesis and redisposition of the necessary structural materials in the surface-layer. At each cell-division there is this alternation.

Cœlentera.

Structure of Metridium.*—G. H. Parker and E. G. Titus describe thirteen fairly well-defined muscles or classes of muscles in this sea-anemone. These represent at least four types of organization: first, independent effectives, as seen in the longitudinal muscles of the acontia; secondly, simple receptor-effector systems, like the circular muscles of the column, which, though brought into action by direct stimulation, are probably also under some nervous control; thirdly, more highly-specialized receptor-effector systems, like the longitudinal muscles of the tentacles, which respond only through nervous stimulation; and, fourthly, complex receptor-effector systems, as shown in the sense-cells of the column wall in conjunction with the longitudinal muscles of the mesenteries. These four types of organization may be regarded as representing

* Journ. Exper. Zool., xxi. (1916) pp. 433–58 (1 pl.).

developmental steps in the evolution of the neuromuscular mechanism of the higher animals.

The nervous system is not limited to the ectoderm and to the endoderm, but in certain regions it penetrates the supporting lamella and thus connects one layer of the body with another. The supporting lamella thus comes to contain nervous elements.

Effector Systems of Actinians.*—G. H. Parker finds that *Metridium* responds to environmental changes by at least four systems—the mucous, the nematocyst, the ciliary, and the muscular. The first three are independent effectors and are not under the control of a nervous mechanism.

The muscular system shows a variety of conditions. Some muscles, such as the longitudinal muscles of the acontia, are independent effectors and are not under nervous control. Others, like the circular muscles of the column wall, may act independently or under the influence of nerves. Still others, such as the longitudinal muscles of the mesenteries, act only in response to impulses from a relatively complex nervous mechanism.

Non-nervous muscular responses are carried out sluggishly and require a minute or more for completion. Nervous muscular responses are relatively rapid and may be accomplished in a second or so. Notwithstanding that the whole musculature exhibits a high degree of tonicity, there are responses, such as the expansion of the œsophagus by the action of the transverse muscles of the complete mesenteries, which are of the nature of well-individualized reflexes.

Larval Actinian Parasitic in Rhizostome.†—C. Badham has found the larvæ of *Peachia hilli* parasitic in a Rhizostome up to the stage at which they have been found free-living. The parasitic larvæ hitherto described live on the exterior of their host, or in the gut, which opens freely by a mouth. The larvæ of *P. hilli*, however, live for a considerable period in the radial canals of *Crambessa mosaica*, a large Medusa common on the coasts of New South Wales. The larvæ occurred in about every tenth Medusa examined during September and October. In the latter month they were observed in the act of escaping from their host through a hole, regular in outline, made in the sub-umbrellar wall of the gut. Some were found with their œsophageal end protruding from the hole, others which had already escaped were adhering to the tentacles of their host. In the genus *Peachia* there is a single deep siphonoglyph, the lips of which come together and form a tube running from the enteron to the exterior, and in some species the external opening is surrounded by a series of lobes forming a conchula. Studying living larvæ still attached to the gut-wall of the host, the investigator found that when the larva is attached by the œsophageal folds it is through the conchula that a constant stream of fluid-bearing food-particles goes to the enteron. He suggests that the larvæ of the

* Journ. Exper. Zool., xxi. (1916) pp. 461–84.
† Quart. Journ. Micr. Sci., ii. (1917) pp. 221–9 (3 figs.).

wide-spread genus *Peachia* are all medusophilous, and that the single deep siphonoglyph, possessing as it does an opening below the œsophageal folds, is a larval organ correlated with the parasitic habit.

Conducting Paths in Ctenophores.*—C. M. Child has studied *Mnemiopsis leidyi*, in which, though a morphologically differentiated nerve has not as yet been found, there seems to be a passage, from the apical region oralwards, underneath the ciliary plates, of an impulse resembling a nerve impulse. An inquiry has been made into the existence of a gradient in metabolic rate or in rate of oxidation along the plate-row, with its highest point at the apical or aboral end. It is found that there is such a gradient in susceptibility to KCN.

The gradient is indicated by the fact that decrease in amplitude of vibration, increase in rhythmic period, and cessation of rhythmic movement occur first at the aboral end of the plate-row, and show a regular progression toward the oral end. Since the plates remain capable of responding to direct mechanical stimulation by beats of full amplitude after the rhythmic beat has ceased, decrease in amplitude and cessation of rhythmic movement must be due primarily to changes in the transmitted impulse rather than in the plates themselves.

This susceptibility gradient is an indicator of a gradient in general metabolic rate and in protoplasmic conduction associated with it. According to the relation between susceptibility and general metabolic condition the aboral end of the plate-row is the region of highest metabolic rate in this gradient, and from this the rate decreases in the oral direction. Many details are given in regard to this "physiological axis," which is fundamentally similar in behaviour to the main body axes of other organisms. These are also in their simplest terms metabolic gradients. The experimental data serve as a basis for consideration of the general significance of metabolic or dynamic gradients as physiological axes, both in the organism as a whole and in its parts, even in axes so highly specialized as nerve fibres.

Protozoa.

Affinities of Entamœba.†—C. Mathis and L. Mercier have made a detailed comparative study of *Entamœba legeri* Mathis from *Macacus rhesus* and *Entamœba coli* from man. They compare the vegetative forms, the development of the cysts, and the division, and show that the agreement is very close. Certain differences in the nucleus and mode of division seem to warrant the separation of the two species. In both the first phase in division is a mesomitosis, but *E. legeri* shows in each half of the dividing nucleus a large chromatic body which arises from a fusion of chromatin granules, and persists for some time in the nuclei of the young amœbæ, first reniform, then like a crescent, then like a horseshoe. This is not seen in *E. coli.*

* Amer. Journ. Physiol., xliii. (1917) pp. 87–112.

† Arch. Zool. Expér., lvi. (1917) Notes et Revue, No. 3, pp. 63–72 (4 figs.).

New Commensal Species of Amœbidium.*—Jean L. Lichtenstein describes *A. fasciculatum* sp. n., which lives as a commensal in the rectum of *Anax imperator* (a dragon-fly) in the larval and sub-imaginal stages. He describes curious "bouquet" stages, cylindrical tubes (endoconidia), united in a bundle. From these there arise amœbæ which encyst. A fixed uninuclear element forms by nuclear multiplication a small number of stationary endoconidia. As these develop they assume the bouquet arrangement alluded to. The genus *Amœbidium* has been sometimes referred to Sporozoa; the author regards it as certain that it should be referred to Protophytes, probably in the vicinity of Eccrinidæ.

Fine Structure of Vorticellid Stalk.†—Salustio Alvarado Fernandez gives an account of the minute structure of the stalk in *Vorticella*. He distinguishes the external elastic sheath and the internal contractile axis. The latter includes a muscular filament (espasmonema) formed of longitudinal myonemes and a plasmatic cord. The cord is a prolongation of the cytoplasm of the bell. Filament and cord are enclosed in a membrane continuous with the cortex of the bell. Separating the filament and cord from the membrane there is a fluid. The central cord has an excentric position and a sinuous course. Some preparations show the sheath divided into a series of transverse disks, or septa, which probably have a mechanical function.

Genus Aspidisca.‡—Harold H. Plough gives a systematic account of this genus of Hypotrichous Ciliata, with diagnoses of the species and a key.

New Crithidian.§—Anna Vivanti describes the structure and life-history of *Crithidia inflata* sp. n. found in the food-canal of *Hygrotrechus najas*, a water-beetle. The cycle includes pre-flagellate, flagellate, and post-flagellate chapters. The flagellates are represented by very narrow forms, long delicate forms with a broad region varying in position, and forms enlarged posteriorly, but with a very delicate terminal prolongation.

In the third.‖ or post-flagellate, stage the posterior part of the organism is somewhat reduced and globular, and the anterior part tends to concentrate towards the nucleus.

The division of the organism is longitudinal, and affects in order the blepharoplast, the flagellum, the nucleus, and the cytoplasm. The author's results are compared with those of Miss Porter in reference to a species of *Crithridia* in *Gerris paludum*, which seems to be distinct.

Parasite of Oocytes of Oyster.¶—L. Léger and A. Ch. Hollande have studied a new Protist, which they call *Chytridiopsis ovicola* sp. n. They found it in the oocytes of *Ostrea edulis* in sparse occurrence. It was observed in a vegetative stage with numerous nuclei; and in state

* Arch. Zool. Expér., lvi. (1917) Notes et Revue, No. 3, pp. 49–62 (7 figs.).
† Boll. R. Soc. Españ. Hist. Nat., xvii. (1917) pp. 125–7 (2 figs.).
‡ Trans. Amer. Micr. Soc., xxxv. (1916) pp. 233–44 (15 figs.).
§ Atti (Rend.) R. Accad Lincei Roma, xxvi. (1917) pp. 132–40 (1 pl.).
‖ Atti (Rend.) R. Accad. Lincei Roma, xxvi. (1917) pp. 174–80 (1 pl.).
¶ C.R. Soc. Biol. Paris., lxxx. (1917) pp. 61–4 (4 figs.).

of sporulation with forty to sixty spores. The spores are spherical, 2·3 μ in diameter, with a very delicate pellicle. Endoparasites of ovarian cells have been very rarely observed.

New Sporozoon.*—O. Duboscq describes *Selysina perforans* g. et sp. n., a curious Sporozoon found by de Selys-Longchamps in the Ascidian, *Stolonica socialis*. At the beginning of its development (nodular cysts with banana-like spores) it suggests a Schizogregarine. The presence of elements of different age in the same thick-walled cyst suggests comparison with Sarcosporidia, such as *Gastrocystis*. Small thick-walled cysts in *Selysina* contain bundles of sporozoites. Large thick-walled cysts in *Selysina* contain multinuclear spheres and heliospores. The heliospores resemble those of *Aggregata*, and suggest that *Selysina* should be ranked provisionally among the Coccidiomorpha. The reactions of the Ascidian in forming nodular cysts is very remarkable.

Sporozoa from Glossobalanus minutus.†—L. Léger and O. Duboscq describe from this Enteropneust three new Sporozoa—*Eimeria* (?) *epidermica* sp. n., *Eimeria* (?) *beauchampi* sp. n., and *Selenidium metchnikovi* sp. n. The first is distinctive in the characters of its nuclei and chromatoid substance. The occurrence of Sporozoa in the epidermis is rare. The schizogony and gamonts of the second and third species are described. Particular attention may be directed to the beauty and detail of the illustrations.

Toxic Action of Copper Compounds of Amino-Acids on Protozoa.‡ J. A. Shaw-Mackenzie has experimented with copper compounds of amino-propionic-acid (alanine) and of amino-acetic-acid (glycine) on *Opalina*, *Paramœcium*, *Amœba*, etc., and finds that the toxicity is very high.

* Comptes Rendus, clxiv. (1917) pp. 450–3.
† Ann. Inst. Pasteur, xxxi. (1917) pp. 60–72 (3 pls.).
‡ Proc. Physiol. Soc., in Journal of Physiology, li. (1917) Nos. 1–2, pp. iii–iv.

BOTANY.

GENERAL,

Including the Anatomy and Physiology of Seed Plants.

Cytology,

Including Cell-Contents.

Chondriomes of the Tulip.*—A. Guilliermond contributes a note upon the chondriomes of *Tulipa suaveolens*. The writer finds the flower of this species particularly suitable for observation since the epidermal cells are unusually large and transparent. The chondriome is composed of a large number of long, thin, undulate chondriocontes, frequently branched and entangled ; granular, rod-like mitochondrias are also present in smaller numbers. In the base of the petals, where a xanthophyll pigment is present, it can easily be seen that the latter is localized in the elements of the chondriome, and the different stages in the elaboration can readily be followed. In the earliest stages the chondriomes are composed of granular mitochondrias and rod-like chondriocontes ; the former appear to be primitive forms of the latter, and gradually disappear. During the growth of the chondrioconte, it is not unusual for transitory grains of starch to be formed, while the chondrioconte becomes charged with a pale pigment and a few fatty globules. These observations are entirely in accordance with those made upon *Iris germanica*, and go to prove that the xanthophyll pigment is elaborated by the chondriocontes.

The same author† contributes a further note upon the subject. He has studied the alterations in the chondriome during the degeneration of the cell and under certain physico-chemical influences. The first change visible is the appearance in the neighbourhood of the chondriocontes of a series of vesicular swellings, each consisting of a globule of colourless liquid surrounded by a thin, pigmented covering. Subsequently these swellings separate into spherical vesicles which increase greatly in size, come into contact with one another, break up and mingle with the cytoplasm, in which the fragments of the pigmented walls are distinctly visible. These alterations, together with those observed under the influence of NaCl, saccharose, osmic acid, etc., show that the mitochondrias are the most fragile elements of the cell, and are the first to show signs of degeneration or osmotic disturbances. It is the transformation of the mitochondrias which imparts the alveolar structure to cytoplasm.

* Comptes Rendus, clxiv. (1917) pp. 407–9.
† Comptes Rendus, clxiv. (1917) pp. 609–12.

General.

Inheritance of Characters in Oat-Breeding.*—F. M. Surface has studied the behaviour of certain glume characters resulting from the crossing of *Avena fatua* with *A. sativa*, Kherson variety. The wild parent has black or dark-brown glumes; the grains have geniculate, twisted awns; the back of each grain is pubescent, and round the base is a thick ring of short hairs; there is also a basal, sucker-like ring which facilitates shattering. In the cultivated parent the grain is yellow, and rarely has an awn; there is no pubescence, and the base is narrow and contracted, so that the grain does not shatter. The F_1 plants are usually intermediate between the two parents; the grain is of a light-brown colour, with medium awns on the lower grains of the spikelets; the lower grains are pubescent, and have bases somewhat like those of the cultivated parent. About 465 F_2 and 70 F_3 plants were obtained, and from these it was proved that the wild parent carries genes for grey and yellow as well as for black, and the ratios approximate to those of Nilsson-Ehle. The cultivated base of the grain is dominant, and its heterozygous condition is clearly seen in most plants. There appears to be reason for believing that the characters mentioned above as belonging to the wild base are due to the existence of separate genes, but it is uncertain to what extent these character-genes are linked to or separate from one another.

CRYPTOGAMS.

Pteridophyta.

(By A. Gepp, M.A. F.L.S.)

Fossil Fern Monstrosity.†—A. Hollick describes and figures a new genus and species of fossil fern—*Anomalofilicites monstrosus*—from the Tertiary (Fort Union Formation), at Kern Ranch, Dawson County, Montana. It appears to be a monstrous form, with some of its pinnæ bipinnate. For comparison with these, some photographs of similar occurrences in the fronds of *Nephrolepis exaltata* are given.

Trichomanes Petersii.‡—E. W. Graves describes the finding of a new station for the rare fern *Trichomanes Petersii* in a damp gorge on Sand Mountain in Alabama, and gives figures of its structure drawn from the type plant gathered in 1853.

Bryophyta.

(By A. Gepp.)

Herberta.§—A. W. Evans gives an account of the hepatic genus *Herberta*, with a revision of the species found in Europe, Canada and

* Genetics, i. (1916) pp. 252–86 (2 pls.).
† Mem. New York Bot. Gard., vi. (1916) pp. 473–4 (2 pls.).
‡ Amer. Fern Journ., vii. (1917) pp. 51–5 (2 pls.).
§ Bull. Torrey Bot. Club, xliv. (1917) pp. 191–222 (pl. and figs.).

the United States. The name *Herberta* Gray is preferable to *Schisma* Dum. and *Sendtnera* Endl. The morphological features of the genus are well marked; and the structure of the rhizome, secondary stems, leaves, underleaves, and vittæ, and the cells and cell-walls, are described in detail. The cells of the vittæ have peculiar thickening bands on their walls, which become obvions when treated with suitable reagents. The male and female inflorescences and the structure of the capsule-wall are described. After a careful study of the European and North American representatives of the genus, Evans has come to the conclusion that they should be grouped in four species:—1. *H. adunca*, found in Scotland, Wales, Norway, Faroe Islands. 2. *H. Sendtneri*, confined to Austria and Germany. 3. *H. Hutchinsiæ*, a new species occurring in the British Isles, Norway, N.W. America. 4. *H. tenuis*, a new species spread over the eastern United States. There has been much confusion and misunderstanding in the past, which is cleared up by Evans's descriptions, figures and key.

Riccia in North America.*—M. A. Howe gives a résumé of the history of *Riccia Beyrichiana* Hampe (1838), originally discovered in Georgia and not found again until 1914, when Howe made a special search for it. The new material suggested that the species is not entirely distinct from *R. Lescuriana* Austin (1869), a species widely distributed in the United States. And a careful investigation of much living material of both species has revealed that in spite of erroneous statements as to size of thallus and spores, presence or absence of marginal cilia, the two species are one and the same—a conclusion which is confirmed by the spore-sculpture. Some of the European material referred to *R. Lescuriana* belongs to it, but non-ciliate European material seems to be more closely related to *R. glauca* or *R. bifurca*. The author also describes the structure of *R. McAllisteri*, a new species from Texas; and adds some notes on the structure of *R. violacea* Howe, and the distribution of that species in the West Indian islands.

Plagiothecium.†—A. Yasuda describes and figures the structure of a new Japanese moss, *Plagiothecium azumense*, which is allied to the European *P. neckeroideum*, but differs in the shape of its leaves, in its laxer areolation, and in the absence of flagelliform branches.

Synopsis of European Sphagna.‡—J. A. Wheldon publishes a Synopsis of the European Sphagna, indicating the species, varieties and forms occurring in the British Isles, with brief descriptions of many of the forms. It is compiled from Warnstorf's "Sphagnologia Universalis" (1911), with additions, and includes fifth-nine species and innumerable varieties and forms, mostly defined with brief diagnoses. Brief key characters are also given in some of the groups, especially in the Cuspidata and Subsecunda. To some extent this synopsis is supplementary

* Bryologist, xx. (1917) pp. 33-6 (1 pl.).
† Tokyo Bot. Mag., xxx. (1916) pp. 89-91 (figs.)
‡ Synopsis of the European Sphagna. Darwen: W. H. Western (1917) 42 pp.

to Horrell's European Sphagnaceæ, where fuller descriptions were given. But the field covered by the synopsis is much wider, and the classification more elaborate. Further, a few new British forms not included in Warnstorf's "Sphagnologia" have been discovered; and some of these are now described. The work has been prepared in the interests of the Moss Exchange Club.

British Mosses.*—W. Ingham publishes the twenty-second annual report of the Moss Exchange Club, giving the customary list of mosses and hepatics contributed by the members. Valuable remarks and criticisms are appended by the referees to some of the items with reference to their structural or morphological peculiarities.

Spanish Bryophytes.†—B. Lázaro é Ibiza has published in his flora a descriptive account of the genera and species of hepatics and mosses found in Spain—94 hepatics and 323 mosses. In the scarcity of other literature on the subject, the present work should be borne in mind. Its value is enhanced by the inclusion of a number of text-figures.

Thallophyta.

Algæ.

(By Mrs. Ethel S. Gepp.)

Chlamydomonas.‡—Y. Kuwada, in discussing some peculiarities observed in the culture of a marine species of *Chlamydomonas*, gives an account of the structure of the plant, its cell-division and swarm-spores, and demonstrates that the cell-wall is of the nature of pectin and not cellulose nor callose.

Structure of Pediastrum.§—R. A. Harper discusses the value of specific types in the well-marked algal genus *Pediastrum*. Very diverse opinions, reviewed in Nitardy's summary,‖ have been held as to the number of species to be recognized, owing to the variation in cell proportions, number and arrangements in the colonies. Harper's study of *Pediastrum* is based on measurements of angles, arcs, etc., made on photo-micrographic enlargements of the eight- and sixteen-celled colonies of *P. Boryanum*. A table of the mathematical results obtained is given on pp. 98, 99, showing the measurements of the interior angles and of the side-walls of the cells in the sixteen-celled colony. It may be possible to fix upon types which present average measurements. The author proposes to publish a further paper on the method of development, and especially the variations in type of both cells and colonies as found in the entire genus.

* York: Coultas and Volans, Ltd., 1917, pp. 177–99.
† Compendio de la Flora Española. Madrid: Hernando (1906), i. ed. 2, pp. 488–554 (figs.).
‡ Tokyo Bot. Mag., xxx. (1916) pp. 347–58 (1 pl.).
§ Mem. New York Bot. Gard., vi. (1916) pp. 91–104 (figs.).
‖ Beih. Bot. Centralbl., xxxii. 2 (1911), p. 111.

Antarctic Fresh-water Algæ.*—F. E. Fritsch publishes his report on the fresh-water algæ of the British Antarctic ("Terra Nova") Expedition. The collection consisted of only eight bottles, of which seven contained material from Cape Adare with practically identical contents. *Prasiola crispa* was largely predominant, with associated filamentous forms. The remaining bottle contained a perfectly typical *Phormidium*-sheet, with a fairly rich epiphytic flora, such as has been described from earlier Antarctic Expeditions. The abundant material of *Prasiola crispa* allowed the author to make a careful study of the filamentous stages associated with it. He distinguishes at least three different types which are occasionally found grading over into one another. These are fully described. Two new species are described, *Phormidium Priestleyi* and *Schizothrix antarctica*, and a new variety, *mixta*, of *Nostoc fuscescens*. The total number of species recorded is twenty.

Algæ of Libya.†—G. B. de Toni and A. Forti publish a second and third contribution to the algæ flora of Italian Libya. The former of these deals with marine species collected by R. Pampanini and a few by A. Trotter. The records, numbering forty-three, are accompanied by critical notes. Lists are given at the end of the paper of marine diatoms washed from various algæ in the district, or collected with sand.

The third contribution‡ deals with the fresh-water diatoms of Italian Libya. In the introduction the authors discuss shortly the flora of Africa in general, and then point out anomalous cases of marine and brackish water species flourishing among the fresh-water species, which they proceed to explain. The fresh-water flora, however, does not lend itself to a comparison with other regions of North Africa, on account of peculiarities due to external factors. The authors hope that further investigation of the colony may lead to a solution of the difficult problems.

Callithamnion Furcellariæ.§—H. Kylin has studied plants of *Callithamnion hiemale* Kjellm. bearing respectively tetraspores and cystocarps, and comes to the conclusion that it is merely a form (f. *hiemalis*) of *C. Furcellaria*. The latter is quite distinct from *C. byssoides*, which frequently has trilobed cystocarps.

Spermothamnion roseolum and Trailliella intricata.‖—H. Kylin confirms the presence of sporangia on individuals of *Spermothamnion roseolum* Pringsh. which are bearing procarpia, as stated by Pringsheim and by Lewis. The sporangia are divided triangularly. The author adds some information regarding *Trailliella intricata* Batters., and shows

* British Antarc. Exped. 1910, Nat Hist. Report, Bot., pt. i. (1917) pp. 1–16 (1 pl.).

† R. Comit. Talassogr. Ital. Venezia, Mem. xli. (1914) 32 pp.

‡ Att. R. Ist. Veneto, lxxiii. (1914) pp. 1441–551.

§ Bot. Notiser, 1916, pp. 65–7. See also Nuov. Notarisia, xxviii. (1917) p. 138.

‖ Bot. Notiser, 1916, pp. 83–92 (2 figs.). See also Nuov. Notarisia, xxviii. (1917) p. 138.

that it has nothing to do with *Spermothamnion roseolum*. He describes certain cells in *Trailliella* with special contents which are lacking in *Spermothamnion*. The cells of the former are twice as long as wide, those of the latter five to ten times. Kuckuck considers that the *S. roseolum* described by Kylin* in 1915 corresponds to *T. intricata*. The author here shows that the two species are quite distinct.

Nemalion multifidum.†—H. Kylin discusses the fertilization and reduction-division of *Nemalion multifidum*, comparing its nuclear behaviour with that of *Scinaia*. The species is generally diœcious, but occasionally is monœcious with a smaller proportion of spermatangia than are found on purely male plants. The author gives an account of the spermatangia, the fusion of the male and female nuclei, the evolution of the carpogonia and the development of the gonioblasts, etc. The germination of the carpospores is of the Chantransioid type.

Thuretella Schousboei.‡—G. B. de Toni publishes a short note on *Thuretella Schousboei*, a specimen of which was collected in July 1916 by Sig. Maccagno at Sestri Ponente near Genoa. He gives a short history of the species from its discovery at Tangiers in 1829 by Schousboe to the present, and remarks on its limited distribution in the Atlantic (Biarritz) and the Mediterranean. He hopes that this note may draw attention to the species and may lead to a search for possible tetrasporic plants.

Bonnemaisonia asparagoides.§—H. Kylin writes on the life-history and systematic position of *Bonnemaisonia asparagoides*, the structure of the thallus, somatic karyokinesis, development of the spermatia, the carpogonial branches, fertilization and chromatic reduction and development of the cystocarp. He regards the systematic position of the genus as being possibly near to *Naccaria*. Finally, he discusses the alternation of generations in algæ, as exemplified in *Chlamydomonas*, *Œdogonium*, *Coleochæte*, *Spirogyra*, *Dictyota*, *Cutleria*, *Laminaria digitata*, and *Fucus*.

Calcareous Algæ.‖—Mme. P. Lemoine reports on the calcareous algæ collected on the Danish Oceanographical Expeditions, 1908–10, to the Mediterranean in the "Thor." Specimens are recorded from Sicily and Greece in 1908; from Spain, Malta, Tripoli, Derna, Tenedos, Sicily, Sardinia, the Balearic Islands, Algeria and the Atlantic coast of France in 1910. Critical remarks on morphology and geographical distribution are appended.

* Ark. f. Bot. xiv., No. 5 (1915) p. 4.
† Ber. d. Deutsch. Bot. Gesell., xxxv. (1916) pp. 257–71 (figs.). See also Nuov. Notarisia, xxviii. (1917) p. 136.
‡ R. Comit. Talassogr. Ital., Mem. lviii. (1917) 7 pp.
§ Zeitschr. f. Bot., viii. (1916) pp. 545–86 (11 figs.). See also Nuov. Notarisia, xxviii. (1917) p. 133.
‖ Report on the Danish Oceanographical Expeditions, 1908–10, to the Mediterranean and adjacent Seas, ii. Biology (Copenhagen, 1915) 30 pp. (1 pl. and 10 figs. in text). See also Nuov. Notarisia, xxviii. (1917) pp. 129–31.

Structure of Spermatozoids of Fucaceæ.*—H. Kylin has made a study of the spermatozoids of *Fucus serratus*, and has cleared up various uncertainties as to their structure, and the parts played by the nucleus and cytoplasm respectively. He finds in the young antheridium a relatively large nucleus with a nucleolus, a frothy cytoplasm (Wabenstruktur), greenish-yellow chromatophores adjacent to the nucleus, and certain small strongly refractive bodies containing fucosan and fat. The nucleus by repeated division gives rise to sixty-four daughter-nuclei, the antherozoids; gradually as division takes place the colour of the chromatophores disappears and their place is taken by leucoplasts. The colour reappears in the sixty-four-nuclear stage, changing from greenish-yellow to orange. These intensely coloured orange chromatophores constitute the eye-spot of the antherozoid. The free antherozoid is pyriform, 4–5 μ long, 2·3–2·5 μ broad; the flagella are unequal, the posterior one being twice as long as the anterior. He notes that the first division is one of reduction, giving thirty-two haploid chromosomes. The author failed to find the "Nebenkernorgane" of Retzius. The chromatophore of the antherozoid is lacking in fucoxanthin, and contains carotin or xanthophyll, or both these pigments.

Sargassum.†—F. S. Collins gives a résumé of the principal papers relating to the Sargasso Sea, and discusses the species of *Sargassum* and other algæ found floating there. The predominant species is *S. natans* (L.) J. Meyen, which through long pelagic existence has become so differentiated from its original ancestor (attached to rocks) that this latter cannot now be identified. The plant exhibits active vegetative growth, but propagates only by fragmentation, and it has a much specialized fauna associated with it. It occurs in scattered patches through an area in the North Atlantic bounded by the Gulf Stream and its subsidiaries, reaching the coast of Europe, thence south and again west to the Gulf of Mexico; fragments may be driven by high winds to the shores of New England and Northern Europe. It is accompanied by *S. fluitans* Börgesen, but in less quantity, and less differentiated from its presumed ancestor, the shore-growing *S. Hystrix* J. Ag. Of equal distribution, but in relatively minute proportion, is *Ascophyllum nodosum* (L.) Le Jolis—which is practically undifferentiated from the parent plant; but though floating and fruiting freely for weeks, probably for months, it cannot be considered persistent in the pelagic condition. Finally, there is a sterile *Cystoseira*, resembling *C. crinita* Bory, found once only; its status therefore is uncertain.

Spanish Algæ.‡—B. Lázaro é Ibiza in his Spanish Flora gives descriptions of the genera and species of fresh-water and marine algæ, illustrated with a number of text-figures. He includes 494 species. In the scarcity of other literature on Spanish Algæ the present work deserves to be kept in mind.

* Ber. Deutsch. Bot. Gesell., xxxiv. (1916) pp. 195–201 (2 pls.). See also Nuov. Notarisia, xxviii. (1917) p. 137.

† Rhodora, xix. (1917) pp. 77–84.

‡ Compendio de la Flora Española. Madrid: Hernando (1906) i. ed. 2, pp. 178–280 (figs.).

Japanese Algæ.*—K. Yendo continues his notes on marine algæ new to Japan. Among the species recorded are *Boodlea composita* Brand, *Spathoglossum cornigerum* J. Ag., *Gigartina unalaskensis* Rupr., *G. ochotensis* Rupr., *Sarcocladia crateriformis* J. Ag., species of *Spongomorpha* and *Acrosiphonia*, and many other interesting species. In many cases the records are accompanied by important critical notes. Under *Dilophus flabellatus* Coll., he explains the apparent proliferations which sometimes occur on the surface of Dictyotæ and Spathoglossæ as being embryonal shoots germinated from the matured spores and still growing attached to the mother frond. They are therefore quite different from the sporiferous proliferations characteristic of *Glossophora*. Under *Lomentaria umbellata* H. & H. he describes and figures the decumbent articuli bearing haptera at their ends, and producing on their upper sides upright shoots to form the erect plant. As a rule the rhizome is limited to the basal part of a frond, but a lower branch on an erect shoot may become modified to assume a similar appearance. *Chylocladia umbellata* is described from such a form. *C. gelidioides* and *Lomentaria catenata* are synonyms of this species. In Japanese specimens of *L. catenata* a fusion of branches is frequently met with, the point of attachment being merely a thickening of the cell-wall, the lamellar structure being more or less distorted at the point of contact. No special haptera or tenacula have been found there.

K. Okamura † describes and figures twenty-one species and varieties of Japanese algæ, including *Codium*, *Halimeda*, *Caulerpa*, *Chordaria*, *Homœostroma*, *Spyridia*, etc. One new species, *Spyridia elongata*, is here published.

Fungi.

(By A. Lorrain Smith, F.L.S.)

Pyrenomycetes.‡—C. G. Lloyd has published a synoptical account of some genera of the large Pyrenomycetes. He passes under review the species classified under *Camillea*. He finds that they form a natural genus or a group which may be broken up into separate genera with further knowledge. In many, the asci disappear and leave a pulverulent mass of spores. *Thamnomyces*, another disputed genus, has a long often-branching stroma to which are closely related certain *Xylariæ*, such as *X. setosa* and *X. gracillima*. The largest Pyrenomycete is *Engleromyces Goetzei*. It was taken by one collector to be a fossilized skull. It only occurs in Eastern and Tropical Africa.

Study of Microthyriaceæ.§—M. G. Arnaud rejects a recent grouping of genera in this family by Theissen and Sydow, who had placed some of the members in the *Polystomellaceæ* because of their immersed

* Bot. Mag. Tokyo, xxx. (1916) pp. 47–55 (figs. 1–4) and pp. 243–263.
† Icon. Jap. Algæ, iii. Nos. 9–10; iv. No. 1 (Tokyo, 1915–16) (pls. cxli–clv.).
‡ Cincinnati, Ohio (1917) 16 pp. (figs.).
§ Comptes Rendus, cxliv. (1917) pp. 574–7.

"hypostroma." Intermediate forms have shown that such an arrangement is not a natural one. Arnaud has recognized two main groups :—(1) *Protothyrieæ*, represented by *Protothyrium* g. n., in which there is no true perithecium ; and (2) *Eumicrothyrieæ*, in which the asci occur in chambers in a stroma. Stoloniferous or fumagine Microthyriaceæ are most common in the rainy tropical districts. Most of them are recognizable at the first appearance of the fungus by their radiate habit of growth.

Prevalence of Endothia gyrosa.*—An examination has been made by Neil E. Stevens of the conditions affecting the distribution of this fungus, which is not always co-extensive with its host-plants. It is an indigenous parasite, and was recorded by Schweinitz about a century ago, but though widespread it is abundant only in the South-Eastern States. It attacks hosts belonging to four genera, *Castanea*, *Fagus*, *Liquidambar* and *Quercus*, the latter the most abundantly. The temperature of the Southern States is that most favourable to its development and continuance, but under certain conditions it will winter further north.

Water-supply and the condition of the host are important factors, and it grows most readily on injured tissues, such as stubs of cut limbs or injured roots. One of the most important agents in securing the greater abundance of the parasite was the increase of opportunity of infection, and that condition prevails in the south, where the host species are more numerous. Injury and exposure of hosts by erosion or by cultural conditions are also aids to attack by the fungus.

Uredineæ.—E. B. Mains† records the first discoveries of *Melampsora* on *Euphorbria* in the Western Hemisphere. Of these, one upon *E. cyparissias* from Maine had been introduced, but species on *E. commutata* from Indiana and on *E. robusta* from Colorado and Wyoming are native. The one on *E. robusta* is a new species, *M. monticola* ; the others have already been described, and are European species.

J. R. Weir and E. E. Hubert‡ record the results of a series of Uredine inoculations. They have decided that the various caulicolous forms of rust on *Pinus contorta* and *P. ponderosa* are the æcidial stages of *Cronartium coleosporoides*. Experiments were carried out with æcidiospores of *Cronartium Comptoniæ* from *Pinus Banksiana* on *Comptonia asplenifolia*, and uredinia were formed. Uredinia were also developed on *Myrica carolinensis* and on *M. Gale*. A number of cultures were also made with *Melampsoræ* on *Populus* and on *Larix* with successful results.

The same writers§ also report an abundant growth of pycnospores of *Cronartium coleosporoides* on *Pinus ponderosa*, which exuded from the pycnidia in September in Montana, thus proving that their production is not confined to Spring months. The exudations consisted of a clear

* Bull. Torrey Bot. Club, xliv. (1917) pp. 125–44.
† Phytopathology, vii. (1917) pp. 101–5.
‡ Phytopathology, vii. (1917) pp. 101–9.
§ Phytopathology, vii. (1917) pp. 135–9 (2 figs.).

sticky sweet liquid, with a large number of minutely pyriform spores in suspension. The pycnidia appear on old galls and lesions caused by the fungus; they are caulicolous and subepidermal, and form minute blister-like swellings when mature. The exudations are cadmium-yellow to orange-coloured, changing to orange or brick-red when dry.

H. B. Humphrey * reports the first appearance of *Puccinia glumarum* in the United States, though it had been collected so long ago as 1892 and then determined as *P. rubigo-vera*. It has appeared, according to these older records, at Seattle, Washington; at Billings, Montana; in Wyoming, and in Utah.

J. C. Arthur † publishes a general review of rusts in the West Indies. Some of the islands, such as Cuba and Porto Rico, have been well searched for rusts, while others, Haiti and Jamaica, "are practically virgin territory, yet awaiting the rust collector. As a general rule, the Cuban flora favours that of North America, that of Porto Rico has more species in common with South America." An interesting feature is the adaptation to climatic conditions; about 65 p.c. of the known species propagate almost, or quite wholly, by uredospores, even those that in temperate regions form teleutospores. Only about 10 p.c. complete the full cycle of life-stages. Short-cycle rusts are very numerous, and full development is rapid.

C. R. Orton ‡ has published an account of American species of *Allodus*. The genus was founded by Arthur, and includes pleomorphic spore-forms which, so far as known, are autœcious. The most conspicuous character of the genus is the frequent close association of æcidia and teleutospores on the same plant parts, and the absence of distinct uredospore sori. Forty-seven American species are listed, with synonymy, host-plants and locality, and several new species are recorded.

F. D. Kern § contributes an account of Japanese species of *Gymnosporangium*, these being of especial interest in the United States as they are liable to gain entrance there along with nursery specimens. The several species are discussed in various aspects.

Pistillaria.‖—E. A. Burt has described a minute Hymenomycete preserved in the Farlow Herbarium at Harvard University. It is characterized by the extreme simplicity of the structure: a few upright hyphæ extend in bundle form from the creeping mycelium, and, at a little distance from the base, branch and terminate in basidia with four sterigmata and spores. Burt records the fungus as *Pistillaria* (sub-gen. *Pistillina*) *Thaxteri* sp. n. It grew on rotten wood at West Haven, Connecticut.

Sandy Sporophores.¶—Albert A. Hansen describes abnormal growth forms of a fungus. They seemed to be exudations of resin

* Phytopathology, vii. (1917) pp. 142–3.
† Torreya, xvii. (1917) pp. 24–7.
‡ Mem. N.Y. Bot. Gard., vi. (1916) pp. 173–208.
§ Mem. N.Y. Bot. Gard., vi. (1916) pp. 245–52.
‖ Ann. Miss. Bot. Gard., iii. (1916) pp. 403–6 (figs.).
¶ Torreya, xvii. (1917) pp. 55–8 (2 figs.).

combined with sand, but all stages were found to be quite recognizable sporophores of *Fomes pinicola*; in many the characteristic shape of the *Fomes* was distinct. The writer concludes that the shifting sands of the beach had become embedded in the sporophores in process of growth, and is a result of mechanical mixing only.

Developments of Agaricaceæ.* — G. F. Atkinson continues his studies on the formation of pileus and gills in species of Agarics. Much macroscopic work has been already done on the subject, but Atkinson has devoted his attention to the origin, differentiation and organization of the spore-bearing parts, as he considers a true knowledge of them is essential to understanding their taxonomic value. The present study deals with *Lepiota cristata* and *L. seminuda*, which are very similar in development, the chief difference occurring in the outer cap, which in *L. cristata* is covered by scales, while in *L. seminuda* the radial hyphæ forming the blematogen become transformed into chains of cells which easily fall apart, giving a mealy appearance to the surface, but which are easily rubbed off, leaving only fragments attached.

Thelephoraceæ.†—E. A. Burt gives in this contribution a study of *Hypochnus*, which he treats as a "natural compact group at the foot of Hymenomycetes, with simple basidia, and closely resembling *Zygodesmus* in general habit and also in form and colour of spores." He finds further that *Hypochnus* is closely related to *Thelephora* and *Grandinia*, and "that the species are apparently humus-formers, as the fructifications are found under any rotten wood and other organic matter rather than on nearly sound wood. Hence they probably follow other fungi in wood-destruction." The spores are rough-walled, or echinulate, and usually coloured; cystidia may be present; the general structure is a loosely interwoven felt. Burt describes thirty-one American species.

A second contribution‡ deals with the genus *Septobasidium*, which is also one of the Thelephoraceæ. It is distinguished by the transverse septation of the basidium and by the *Corticium*-like habit. The species are tropical or sub-tropical, and occur on living branches or leaves, without, however, being parasitic. They have been observed to be associated with scale-insects, and it is noteworthy that their spores are produced when young colonies of scale-insects are forming. The species are fully described, and the basidia and spores are figured.

Distribution of Hymenomycetes with reference to Ectotrophic Mycorhiza.§—B. Peyronel publishes his observations as to the fungi that form mycorhiza, and their occurrence in association with certain trees. He found in plantations of *Larix decidua* a preponderance of *Boleti*; among Cupuliferæ there were more Agarics than Polypores. In the family Salicaceæ, *Populus tremula* is always accompanied by a rich

* Mem. N.Y. Bot. Gard., vi. (1916) pp. 209–28 (6 pls.).
† Ann. Miss. Bot. Gard., iii. (1916) pp. 203–41 (29 figs.).
‡ Ann. Miss. Bot. Gard., iii. (1916) pp. 319–43 (14 figs.).
§ Atti Real. Accad. Lincei, cccxiv. (1917) pp. 326–32.

development of soil Hymenomycetes, while *Salix alba* was without any. *Betula alba* is accompanied by a certain number; under *Alnus glutinosa* a *Lactarius* was constant; *Alnus viridis* was without characteristic soil fungi. These and other facts are discussed, and the writer concludes that soil Hymenomycetes abound in connexion with trees and other plants that harbour mycorhiza, and that they are absent from the non-mycorhizal plants. He finds in this a proof that mycorhiza for the most part is a fungus belonging to the Basidiomycetes.

Bermuda Fungi.*—Fred. J. Seaver contradicts the statement that few fungi occur in Bermuda, though he admits that the larger Basidiomycetes are not so abundant as in other regions. Thirty-two species of these have been determined. A fairly long list is published of other fungi collected and determined in which the *Fungi imperfecti* and the Ascomycetes bulk largely. Among the latter are four new species belonging to *Ascophanus*, *Nectria* and *Calonectria*. About 150 species were collected during a two weeks' visit to the islands, but many of them are still undetermined.

New Japanese Fungi.—A. Yasuda† describes a new species, *Polystictus nipponicus*, a small plant of imbricate growth, white above, though becoming brown when dry, with minute pores and globose small spores. The new species was collected from the trunks of trees.

A new *Thelephora* is also described by Yasuda.‡ It is very similar to *T. papillosa* Lloyd, but differs in the smooth dark colour of the upper surface.

Takewo Hemmi § gives a list of new microfungi parasitic on Japanese plants, mainly on the leaves. Species of *Crasterosporium Septoglœum*, *Septoria* and *Armatella* are included. There is no mention of any serious damage done to the plants attacked.

Yasuda ‖ also describes an Ascomycete, *Leotia japonica* sp. n. It somewhat resembles *L. atrovirens*, but is a much larger plant. It grew on damp soil.

African Microfungi.¶—R. G. Fragoso has published a list of microfungi collected by D. A. Caballero at Melilla (Marruecos). They are all minute parasites on economic or other plants. The species *Sphærulina maroccana* on *Trifolium Bocconi*, and *Microdiplodia iridicola* on *Iris filifolia*, are new to science.

New or Noteworthy Fungi.**—C. G. Lloyd publishes descriptive and critical notes on many unusual species of fungi from all over the world. Several Polyporeæ and allied genera, such as *Irpex* and *Lenzites*,

* Mem. N.Y. Bot. Gard., vi. (1916) pp. 501–11.
† Bot. Mag. Tokyo, xxx. (1916) pp. 291–2 (1 fig.).
‡ Bot. Mag. Tokyo, xxx. (1916) pp. 345–6.
§ Bot. Mag. Tokyo, xxx. (1916) pp. 334–44 (5 figs.).
‖ Bot. Mag. Tokyo, xxxi. (1917) pp. 1–2 (5 figs.).
¶ Bol. Hist. Nat., xvii. (1917) pp. 78–83.
** Mycological Notes, Cincinnati, Nos. 45–6 (1917) pp. 622–52 (figs.).

receive attention. There is a discussion on *Seismosarca*, which he thinks may be the same as *Exidiopsis* of Moeller. *Cyclomyces Greenii* from Japan is another rare plant which is figured; in it the gills are concentrically arranged. Several species of *Xylaria* are also figured and commented on. In Note No. 46 many Gasteromycetes are recorded. Special attention is given to *Mesophellia*, an Australian genus of Lycoperdaceæ with hard core. *Diploderma*, an allied genus, has an inner hard peridium, but no hard core. *Arachnion*, a very rare genus, has been sent to Lloyd from South Africa; it has a thin peridium, which makes it a very fragile fungus difficult to preserve. There are now several species from South Africa, America, and Australia.

Spanish Fungi.*—A descriptive "compendium" of Spanish plants is in course of publication by Blas Lazaro é Ibiza. In the first volume the Fungi are dealt with along with other classes. Ibiza gives a short sketch of the nature and habitat of Fungi, which he divides into two sub-classes: Myxomycetes and Hypodermeæ, or Fungi proper. He begins with Ustilagineæ and Uredineæ, then Basidiomycetes, and Ascomycetes with which are incorporated the Fungi Imperfecti, and he winds up with the Phycomycetes. The Spanish genera and species are described, and a clavus to the genera is given. A number of forms are figured.

Fungi and Lichens from Somali-Land.†—The botanical collection made during the Stefanini-Paoli Expedition to Italian Somali-Land has been dealt with by systematic botanists, and included therewith are a number of fungi and lichens. The fungi, all of them Eumycetes, have been worked out by P. Baccarini. The list includes a number of new species belonging to *Tulostoma Lentinus*, *Pholiota*, *Polyporus*, and *Fomes* among the larger forms, while in the more microscopic sections there are new Uredineæ, Sphæriaceæ, Hysteriaceæ, etc. The list of lichens is compiled by C. Zanfrogini. They comprise Graphideæ, Usneaceæ, etc.

Experimental Study of Fungi.‡—B. M. Duggar and A. M. Davis have studied a series of Microfungi to test their capacity for nitrogen fixation which has been repeatedly affirmed or denied by various workers. Previous work on the subject is passed in review, and the methods, old and new, are described. The results gained in the present research are carefully tabulated. The authors could not demonstrate fixations in *Aspergillus niger*, *Macrosporium commune*, *Penicillium digitatum*, *P. expansum*, and *Glomerella Gossypii*. In most of these fixation had been proved, but only of very small quantities of nitrogen. They were more successful with *Phoma Betæ* on cultures of mangold, and on sugar-beet decoction with sugar they found a nitrogen gain.

* Bot. Descr. Comp. Fl. Esp., i. (Madrid, 1906) pp. 280–427 (100 figs.).

† Le Coll. Bot. Miss. Stef.-Paoli, Somalia Italiana (Firenze, 1916) pp. 189–200 and 228.

‡ Ann. Miss. Bot. Gard., iii. (1916) pp. 413–37.

Comparative studies were made with *Azotobacter*, and the usual gain of nitrogen appeared in the cultures.

A second contribution * reports the results of an experimental study on the wood-destroying fungus *Lenzites sæpiaria*, with special reference to enzyme production and action. Most of these are formed in the vegetative mycelium, though oxidases are more active in the sporophores.

Chemotropic Reactions in Rhizopus nigricans.†—Arthur H. Graves gives a contribution to our knowledge of the behaviour of fungal hyphæ in relation to chemotropic stimuli. The fungi experimented with were *Rhizopus nigricans*, *Botrytis cinerea* and *Penicillium*, and perforated mica plates were used in the cultures. Graves found that the fungi exhibited a negative chemotropism toward their own metabolic products (staling products), and the negative influence was much stronger than the positive influence of culture media, such as turnip-juice, cane-sugar and glucose. "The distribution of parasitic fungi in the host-plant is therefore probably due, not so much to positive chemotropic stimuli, as to the dominant negative chemotropism towards their own staling products."

Plant Diseases.‡—F. L. Stevens has given a list of Porto Rican plant diseases, of economic importance, with short notes. Among the most interesting are *Hemileia vastatrix*, which appeared on coffee, but was recognized and immediately stamped out. Another disease of coffee, *Pellicularia koleroga* allied to *Hypochnus*, is prevalent and very destructive; it attacks the leaves. Various forms of black moulds occur on leaves:—*Meliola* on palm, on orange, on mango, and on guava. Uredineæ such as *Graphiola Phœnicis* on palms; *Uredo Artocarpii* on bread-fruit; *Uromyces* on pea-nut, gondule and manihot; *Kuehneola Gossypii* on *Ficus* and cotton; and *Coleosporium* on sweet-potato.

"Leaf Spot," § or blight of celery (*Septoria Apii*), has been greatly on the increase in recent years. The disease attacks the outer leaves first, and they become discoloured and finally rot away. On the discoloured areas may be seen the minute perithecia that are the fruits of the fungus. The fruits of the celery may also be diseased, so care is advisable in choosing clean seed, and all diseased plants should be carefully burned.

Sharples ‖ has shown the rôle played by insects in spreading the collar rot of rubber-trees (*Hevea brasiliensis*). The disease is due to the fungus *Ustulina zonata*, and it has been found that a plantation is often attacked at the time of thinning operations when the trees are about six or seven years old. The trees that are left are often wounded on the bark, accidentally abraded by others falling against them, and so the attack of boring beetles (*Xyleborus parvulus*) is facilitated and becomes very common. The fungus follows in the tracks of the beetles, these providing a ready entrance for the mycelium. It is also pointed out

* Ann. Miss. Bot. Gard. iii. (1916) pp. 439–509.
† Mem. N.Y. Bot. Gard., vi. (1916) pp. 323–31.
‡ Phytopathology, vii. (1917) pp. 131–4.
§ Journ. Board Agric., xxiv. (1917) pp. 68–70 (1 pl.).
‖ Dept. Agric. Fed. Mal. Stat., Bull. 25 (1916). See also Nature, xcviii. (1917) p. 500.

that at the time of thinning the trees contain a large amount of suitable food material for the fungus in the form of soft rubber wood, and it therefore follows that the thinning-out stage is the most dangerous one in the life of the plantation.

Takewo Hemmi * has written a full account of a die-back disease of *Paulownia tomentosa* caused by a fungus, *Valsa Paulowniæ* Miyabe & Hemmi sp. n. It attacks branches and trunks of the tree at any age, though young trees are most liable to disease; the bark turns brown, and the area of disease gradually extends. After the stem is dead, the fructifications of the *Valsa* appear: first a small black stroma containing the pycnidia, later the ascosporous stage. The fungus grows well on cultures, though the ascosporous stage is more difficult to reproduce.

A root-rot fungus from Texas, which has only been found so far in the conidial stage, has been described tentatively by B. M. Duggar † as *Phymatotrichum omnivorum*. Such various host-plants are enumerated as *Ulmus*, *Morus*, *Ficus*, *Acer*, *Tilia*, *Cydonia*, *Robinia*, *Prunus*, etc., though the disease was first known as cotton-blight, and was described as *Ozonium omnivorum*. The plants are attacked at the root, and very quickly die off. The hyphæ invest the roots with a weft of small strands, and these strands may spread for a long distance through the soil; they are colourless, or pale-buff, when young, becoming brown when old. The different growth stages and the fructification are described, and a bibliography of works bearing on the subject is appended.

J. C. Gilman ‡ has published an account of the relation of temperature to the occurrence of the disease known as Cabbage Yellows, which is caused by the fungus *Fusarium conglutinans*. This is a facultative parasite living in the soil, and, under certain conditions, becomes destructive to cabbage, causing the yellowing and finally the falling-off of the leaves by the formation of an abscission-layer. The disease is most active between the temperatures 17–22° C. Lower temperatures prevented the occurrence of the disease in controlled areas. A large bibliography of works bearing on the question is given.

In a contribution concerning silver-scurf on potatoes it is stated by J. J. Taubenhaus § that (1) it has been proved that *Sponylocladium atrovirens* Harz is the cause of the disease; (2) that it is only a skin-disease, and is carried with the seed and soil. Another fungus, recorded variously as *Phellomyces sclerotiophorus*, *Vermicularia atramentaria*, and *Colletotrichum solanicolum*, but, by rules of priority, to be now known as *Colletotrichum atramentarium*, is entirely unconnected with *Spondylocladium*; it is apparently a saprophyte, or at best a very weak parasite, and, though frequently found on the spots caused by silver-scurf, is merely a secondary invader. Silver-scurf itself does not produce scab or rot; when such symptoms accompany its appearance, they are due to *Fusaria* or other fungi.

* Bot. Mag. Tokyo, xxx. (1916) pp. 304–15 (4 figs.).
† Ann. Miss. Bot. Gard., iii. (1916) pp. 11–23 (5 figs.).
‡ Ann. Miss. Bot. Gard., iii. (1916) pp. 25–84 (2 pls. and 21 figs.).
§ Mem. N.Y. Bot. Gard., vi. (1916) pp. 549–60 (3 pls.).

Buck-eye Rot of Tomato.*—C. D. Sherbakoff describes this disease, which affects only the fruit of the tomato, as being due to *Phytophthora terrestria* sp. n. It occurs on the fruit in all stages of its development, beginning almost invariably at the point where the fruit touches the ground, which is generally at the blossom end. The name "buck-eye" has reference to the broad zonation on the diseased fruit due to the fungus. The same fungus was found by the writer in the bark of trunks of *Citrus* trees causing foot-rot, and in stems of a Lupine causing stem-rot; as it only attacks fruit that touches the ground it apparently exists in the soil. Many cultures and experiments were made: inoculations into wounded fruit always showed the rot in twenty-four hours; into unwounded fruit occasionally after the same period of time, but more generally not till three or even four days later. Comparisons are made with allied fungi.

Fig Rhizoctonia.†—This fungus was found on leaves, twigs, and fruits of *Ficus carica* at Gainesville, Florida. J. Matz describes it as a silvery to yellowish-white mycelium on the surface of the invaded areas. No spores have been found, but sclerotia connected with it by fibrils have been observed similar to those of *Rhizoctonia*; they are superficial, adhering by slender mycelial strands to the petioles and to the stems of fruit and branches. Pure cultures were grown easily, and healthy fig-trees were infected. Matz compares the organism with other *Rhizoctoniæ* and finds that it is a new species, *R. microsclerotia*.

Rhizoctonia Solani.‡—B. M. Duggar has made an extended study of this fungus and of its occurrence under other names. He has concluded that the common seed-bed fungus, though included in *Sclerotinia* by various writers, really belongs to *Rhizoctonia*, and is identical with the damping-off fungus *Rhizoctonia Solani* (*Corticium vagum*). The latter condition is well known as the cause of important diseases of potatoes, &c. Recently a disease of *Cinchona* seedlings and of other plants in Java known as the Mopopliz has been referred to the same fungus. A copious bibliography is appended.

Pathogenic Yeast-fungi in the Higher Animals.§—W. H. Emig has investigated a large series of these fungi by cultures and by infection experiments. The fungi which develop in yeast-forms belong to the Phycomycetes, the Hyphomycetes, and the Saccharomycetes.

From observations made, the author has concluded that fungi, not including bacteria, are of secondary importance in the formation of lesions in animal bodies, and usually appear secondarily in animal tissues. On the other hand, fungi may be of primary importance when consumed in large quantities as moulds on infected foods. He has concluded also that pathogenic yeasts do not occur in nature; all experi-

* Phytopathology, vii. (1917) pp. 119–29 (5 figs.).
† Phytopathology, vii. (1917) pp. 110–8 (2 pls. and figs.).
‡ Ann. Miss. Bot. Gard., iii. (1916) pp. 1–10.
§ Ann. Miss. Bot. Gard., iii. (1916) pp. 243–307 (13 figs.).

ments with those found in nature have given negative results. An account of cultures and experiments is given, with a copious bibliography in which is included the works dealing with the fungi that cause disease.

Lichens.

(By A. Lorrain Smith, F.L.S.)

Spanish Lichens.*—A descriptive account of these is given by Ibiza in his "Compendium" of Spanish plants. A critical account of the thallus is given, and the classification adopted is explained, comprising four orders—Leprariæ, Collemeæ, Endocarpeæ, and Gymnocarpeæ. About 450 species are recorded for Spain. Many have probably been overlooked.

Schizophyta.

Schizomycetes.

Bacteriology of Rubber Latex.†—Denier and Vernet have investigated the flora concerned in the natural coagulation of the latex of *Hevea brasiliensis* (the common rubber-tree of commerce), and have succeeded in isolating no less than twenty-six different species of aerobes, or facultative aerobes, and an anaerobe from specimens of latex submitted to examination. The various species isolated included cocci-coccobacilli and bacilli, some of the latter being chromogenic, or possessing terminal or median spores. One bacillus of constant biological characters was isolated from all the specimens examined. Its characters were as follows:—Short bacillus with rounded extremities, very motile and not stained by Gram's method. Greyish-white growth on ordinary sloped agar. Vigorous growth on litmus latex serum-agar, with the production of acid and a small quantity of gas. Acid and gas were produced in saccharose and lactose litmus-agar, gas production being particularly well marked in the latter medium. Acid and clot produced in litmus milk. No proteolytic action on egg-white, but liquefaction of gelatin produced. When tubs containing rubber latex were inoculated with culture of this microbe, complete coagulation was produced in twenty-four hours; but sometimes it was found necessary to accelerate the action by adding sugar. Zinc tubs cannot be used, as the presence of zinc salts inhibits the growth of the micro-organism.

Affinities of Pseudo-dysentery Bacilli.‡—L. Négre has examined a series of cases of pseudo-dysentery at the Pasteur Institute of Algiers. With regard to their action upon sugars, their agglutination reactions, complement fixation reactions, and pathogenic capacities, they appear to belong to a group intermediate between the true dysentery bacilli and

* Bot. Descr. Comp. Fl. Esp., i. (Madrid, 1906) pp. 427–87 (14 fig.).
† Comptes Rendus, clxv. (1917) pp. 123–6.
‡ Ann. de l'Inst. Pasteur, xxxi. (1917) pp. 172–85.

Bacillus coli. Some members of the group are motile, others are non-motile. Most of them ferment glucose and lactose with production of gas, and thus bear a close resemblance to *B. coli.* The following table clearly shows the affinities of the group with dysentery bacilli on the one hand, and with *B. coli* on the other.

NON-MOTILE PSEUDO-DYSENTERY BACILLI. AGGLUTINATIONS.

Serums.	Shiga.	Flexner.	Ray.	Bou.	Ali.	Sau.	Ron.	Ber, 3103.	Danv.	*B. coli.*
Races—										
Flexner .	..	1/100	1/10	4/500	..	..	..	..	..	..
Ray . .	..	1/1000	1/5000	1/100	..	..	..	..	..	..
Bou . .	..	1/100	1/100	1/5000	1/100	1/100	..	..	..	..
Tr. . .	..	1/100	1/100	1/500	1/500	1/100	..	..	..	..
Ali . . .	..	..	1/100	1/1000	1/1000	1/100	..	..	..	..
Sau . . .	..	..	1/100	1/500	1/1000	1/5000	..	1/100	..	..
Lacas . .	..	..	1/100	1/500	1/100	1/100	1/100	1/100	..	1/500
Riv . .	..	..	1/100	1/1000	1/1000	1/1000	1/500	..	..	1/500
Ron . .	..	..	..	..	..	..	1/500	1/100	..	..
Dout . .	..	..	..	..	..	..	..	..	..	1/100
Ber, 3182 .	..	..	..	..	..	..	..	..	..	..
Ber, 3103 .	..	..	..	..	..	..	..	1/500	..	..
Danv . .	..	..	..	..	..	..	..	..	1/500	..
B. coli	..	..	..	..	.	..	1/500	1/500	..	1/500

Saturation Deficiency and Temperature in relation to Plague.* R. St. John Brooks has studied the combined effect of saturation deficiency and of temperature on the course of epidemic plague, and has come to the conclusion that in the majority of cases they exert an influence on the course of the disease. Under certain conditions, however, plague epidemics come to an end when the climatic conditions are presumably favourable for a continuance of infection. In these cases other factors must come into play, such as the seasonal breeding of rats, the decrease in the number of rats during epidemic periods, and the accompanying increase in the proportion of immune to susceptible rats. The adverse influence of high temperature and saturation deficiency may be explained by their effect on the duration of life of the rat-flea, *Xenopsylla cheopis*, when separated from its host. When the mean temperature rises above 80° F., and when such rise is accompanied by an increase in the saturation deficiency to above 0·30 of an inch, plague cannot maintain itself in epidemic form, though a high temperature *per se* may not bring about the termination of a plague epidemic. Many examples can be adduced of plague epidemics coming to an end when the temperature remains well below 80° F., and in such cases the determining factor appears to be the rising of the saturation deficiency to over 0·30 of an inch.

* Journ. Hyg. Plague, Suppl. v. (1917) pp. 881–99.

Plague epidemics do not, as a rule, arise when the mean temperature is above 80° F., for the reason that at such temperature it is quite exceptional to find a sufficiently low saturation deficiency. When, however, a high temperature occurs with a low saturation deficiency, plague epidemics do arise and maintain themselves. In Rangoon, where the temperature, although above 80° F. for over nine months in every year, is associated with an exceptionally low saturation deficiency, plague occurs at all seasons of the year. The autumnal recrudescences of plague in Bombay are found associated with a mean temperature of over 80° F., but with a low saturation deficiency of less than 0·20 of an inch.

Generally speaking, it may be said that there is a critical saturation deficiency for each range of temperature. At 80° F. this critical saturation deficiency appears to be of the order of 0·30 of an inch. At lower ranges of temperature a higher degree of deficiency is needed to suppress the epidemic, while at higher temperatures a somewhat lower deficiency will suffice.

MICROSCOPY.

A. Instruments, Accessories, etc.*

(3) Illuminating and other Apparatus.

Biprism for the Greenough Microscope.†—E. M. Nelson writes that while the Greenough binocular works well with unmounted objects seen by reflected light and objects viewed upon a dark ground with a spot lens or condenser and stop, yet with objects seen with transmitted light there is a difficulty in illuminating both tubes; for obviously if the mirror were placed so that light was reflected in one tube, the mirror would not be in a proper position for reflecting light into the other. The difficulty was overcome by means of a biprism and was found to answer the purpose perfectly. The prism, made by C. Baker, is mounted upon a circular plate of glass and drops into the stop-holder at the back of the condenser fitting; it can be used with or without the condenser or with or without the stop.

Zeiss Abbe Refractometer.‡—A communication has reached "Nature" from Bellingham and Stanley, Ltd., in which attention is directed to an interesting point in connexion with the design of the Zeiss Abbe refractometer. It has been observed recently by users of the instrument that, owing to want of illumination, measurements cannot be made for liquids having a refractive index greater than 1·52. It is plainly stated in the Zeiss catalogue that the Abbe refractometer may be used for the measurement of refractive indices from 1·30 to 1·7, and that the liquid to be examined is enclosed between two prisms of flint glass. In the instrument as actually constructed it appears that a crown glass prism of low refractive index ($N_D = 1·52$) has been substituted for the dense flint prism ($N_D = 1·75$) used at first as the lower or illuminating prism. The contact surface of this prism is left unpolished, so as to scatter the light entering the liquid film. The process of wiping the surface to remove the liquid which has been examined results in the removal of the thin sharp walls left by the abrasive, and the surface approximates to a polished face. When this is the case very little light can fall on the contact surface of the liquid and the upper prism at angles greater than the critical angle unless the lower prism has a refractive index greater than that of the liquid under test; for it is only when this condition is satisfied that light entering the liquid is bent away from the normal. Several such instruments have been rendered

* This subdivision contains (1) Stands; (2) Eye-pieces and Objectives; (3) Illuminating and other Apparatus; (4) Photomicrography; (5) Microscopical Optics and Manipulation; (6) Miscellaneous.

† English Mechanic, May 18, 1917, p. 271.

‡ Nature, June 21, 1917, p. 331.

serviceable for the measurement of liquids of refractive index as high as 1·70 by replacing the crown illuminating prism by a suitable dense flint prism. In using the refractometer for solid and plastic bodies it would be more convenient if the prism box were designed to open away from the operator.

(4) Photomicrography.

Exposure in Photomicrography.*—F. C. Lambert has compiled three tables which are intended to afford means of scientifically calculating the exposure required when any of the essential factors (light source, object, objective, plate) are varied. The tables are too elaborate for reproduction, but they, as well as the subsequent discussion at the Royal Photographic Society, should be read by those interested in the subject.

(6) Miscellaneous.

"The Microscope." †—The twelfth edition of this valuable work, by S. H. Gage, has now been published, and the contents of the present editions have been thoroughly revised. In his preface the author appeals to the comparison of manufacturers' ten-year old and modern catalogues for a realization of the advances in microscopy during recent years. Although nothing fundamentally new has appeared within the last ten years, yet many processes have been made applicable and much apparatus has been rendered really serviceable. Among the most important developments, especially for students of biology, the author reckons the following :—1. The single objective binocular for all powers of the Microscope from the lowest to the highest. 2. The dark field illuminated for all powers, especially the highest, with which the finest details in living structures can be seen with marvellous clearness. This makes it possible to compare the living cell with the fixed and stained one. 3. The perfection of apparatus with which the powerful electric lights recently produced have become available for demonstrations and for drawing with the projection Microscope. 4. The perfection of photographic light filters, and the production of dryplates, sensitive to the whole spectrum, make it possible to get good photographs of any microscopic specimen, and indeed of any specimen. 5. From the numbers who are affected, and the extent of its application, perhaps the greatest improvement of all has been the production of a glass filter, which, when used with a gas-filled Mazda lamp, gives a light of true daylight quality, and of sufficient intensity for all powers of the Microscope.

The author endeavours to render the microscopist thoroughly master of the principles and manipulations, and he spares no pains, by descriptions and figures, to attain this object. The recent improvements are treated with especial care. He omits the pages relating to micro-

* Photographic Journal, lvii. (June 1917) pp. 205–15 (5 figs.).

† The Microscope: an Introduction to Microscopic Methods and to Histology, by Simon Henry Gage. Ithaca, N.Y.: Comstock Publishing Company, 1917. ix. and 472 pp. (252 figs.).

chemistry and metallography, because these have been so adequately treated in Dr. E. M. Chamot's recent "Micro-Chemistry." About one-fourth of Page's book (pp. 312–443) is taken up with materials of microscopy and preparation of objects. Nearly three-fourths are given to the elucidation and application of microscopic apparatus, and the remainder is concerned with a very interesting historical sketch of lenses and microscopes. There is also a good bibliography.

Direct Microscopical Counting of Bacteria in Water.*—B. E. Nelson says that the estimation of the number of bacteria in water by direct counting has several advantages over plating methods. Although requiring more skill than the latter it occupies much less time and avoids the necessity for preparing and sterilizing culture media. Plating methods give low results in general, because there are always some organisms present which fail to produce colonies, and clusters of organisms cannot be distinguished from isolated individuals, since they only give rise to single colonies. The results obtained by direct counting are, on the other hand, liable to be high, owing to the inclusion of dead cells in the counts. Direct counting gives opportunity for observation of the various types of organisms present, although at the sacrifice of the characteristic colony formations and other biochemical reactions during growth on plates which are often used as diagnostic points.

In applying the method of direct counting to potable waters, which are relatively clean, it is necessary to concentrate the organisms into a small volume, e.g. those from a litre into 1–3 c.cm. In order to effect such a concentration, whether by sedimentation, filtration, or centrifuging, it is necessary to use colloidal "flocking" materials, and the most suitable appears to be zinc hydroxide, as after concentration this can be redissolved by addition of ammonium chloride so as not to interfere with the counting. The precipitate is formed by adding to a litre of the water 1–5 c.c. of 5 p.c. zinc sulphate solution, followed after two to three minutes by the proper amount of caustic soda (0·7–3·7 c.cm. of N. caustic soda); the liquid is shaken thoroughly and allowed to stand for a few minutes with occasional shaking. The organisms in the water become entangled in this precipitate, and can be concentrated with it into a small volume. The author studied three methods of concentrating—viz. by allowing the precipitate to subside spontaneously, by filtering it on a layer of sand, and by centrifuging; in all cases the precipitate, after separation from the bulk of the water, was finally concentrated to 1 or 3 c.cm. in a small medical centrifuge. Full working details of the methods adopted are given. It is estimated that the precipitate separated by filtration on sand contained more than 99 p.c. of the bacteria originally present in the water; that separated by centrifuging contained about 92 p.c., whilst that deposited spontaneously only contained 80–86 p.c. Whilst therefore the filtration method proved most efficient, the centrifugal method was by far the most

* Journ. Amer. Chem. Soc. No. 39 (1917) pp. 515–23, through Journ. Inst. Brewing, xxiii. (1917) pp. 259-61.

expeditious, occupying only fifteen to twenty minutes from the outset of the operations to the commencement of the counting.

After the concentration of the precipitate, the zinc hydroxide is redissolved by addition of ammonium chloride, and a large drop of alkaline methylen-blue or clear carbol fuchsin is added as stain. The volume is made up exactly to 1, 2, or 3 c.cm. as desired, and, after mixing, a number of counts are made. For counting, one of the ruled cell-slides, known as cytometers, may be used. The Thoma-Zeiss hæmocytometer was found to give good results. In this the ruled portion has a capacity of 0·1 cubic mm., and this is ruled into twenty rows of squares of twenty squares each. The author has obtained as good or better results with a cell made by evenly grinding a circular depression into a fairly thick Microscope slide, about 10 mm. in diameter and exactly 0·1 mm. deep; the depth may be measured by means of the micrometer head of the Microscope. A slight notch filed in one side allows any excess of fluid to escape. In using it a large drop of the well-mixed concentrate is placed in the cell and covered by firmly pressing down a perfectly plain cover-glass, and the bacteria in the whole field are counted. A Sedgwick-Rafter micrometer, ruled in squares and placed in the eyepiece, greatly facilitates counting when there are many organisms. The proper regulation of the light coming from the condenser is highly important for seeing the bacteria clearly, and a dark-ground illuminator is also sometimes used. A magnification of 400 to 500 diameters is quite sufficient. The capacity of each standard Microscope field is determined once for all, from the depth of the cell and the diameter of the field as measured by a stage micrometer. An experienced observer will count a standard field in two to sixty seconds, according to the number of bacteria. The number of fields to be counted depends on the density of the bacteria and the uniformity of their distribution; usually from 10 to 50 should be counted, and the average multiplied up properly according to the capacity of the standard field and the volume of concentrate. The following figures represent counts of fields for the same liquid:—24, 28, 55, 130, 16, 85, 163, 44, 27, 18; average 59. Variations are chiefly due to the occurrence of clumps of bacteria.

The accompanying table shows the results of direct counts obtained with various types of water compared with the results found by means of agar and gelatin plates:—

Water.	Agar plates.	Gelatin plates.	Direct.
River	800	650	2100
	650	550	900
	9000	liquefied	16,000
Filtered	12	10	25
	18	12	30
Reservoir	1300	1400	2000
Ditch, turbid	15,000	liquefied	100,000
Well, shallow	12	8	15
Well, deep	7	..	30

The results found by direct counting are more accurate than those obtained by plating, but, as shown by the table, they are not directly comparable with them. These total counts are in no sense intended to supersede the specific cultural and other tests for *B. coli* or other individual groups of organisms.

B. Technique.*

(1) Collecting Objects, including Culture Processes.

Culture Medium for Rapidly Detecting the Presence of Bacilli of the Typhoid Group.†—C. Botelho has devised a medium the principal ingredient of which is the "cotton-blue Poirier C_4 B." This is dissolved in lactophenol Amann (lactic acid 1, pure carbolic acid crystal 1, glycerin 2, distilled water 1), and diluted with a third of distilled water. 2. White sugar 200 grm., completely dissolved in 100 grm. water. 3. 2 p.c. solution of NaHO. 4. Agar 15, pepton-Chapoleaut 10, salt 5, water 1,000 grm. Sterilize after complete solution.

The medium is made as follows:—In a flask put 100 grm. of the agar, liquefy and add 2 c.cm. of the cotton-blue solution, and 10 c.cm. of the sugar solution, boil, and then add 7 c.cm. of the caustic soda to 2 per 100. Boil again till the agar is completely decolorized and afterwards distribute into tubes.

Tubes inoculated with bacilli of the typhoid group become blue in four or five hours, while the coli group tubes remain uncoloured.

(2) Preparing Objects.

The Examination of Dysenteric Stools for Amœbæ Cysts.‡—J. Carles and E. Barthélemy describe the following method of searching for amœbæ cysts in stools from dysenteric patients. After mixing the stool thoroughly, 20 grm. are placed in a glass of 125 c.cm. capacity. Add, while stirring, a sufficient quantity of diluting fluid to obtain a homogeneous emulsion (the diluting fluid consists of salt solution and 10 p.c. formalin). Pass the emulsion through a silk sieve of 90 meshes to the centimetre, of which the interstices are of an average of 60 μ (when searching for helminth ova employ a sieve of 32 meshes to the centimetre with interstices of 225 μ). The liquid obtained after filtering is distributed in tubes and centrifuged for one minute at a speed of 1,800 revolutions per minute. Reject the supernatant fluid and dilute the residue with the following liquid:—Citric acid 12 grm., water 86 grm., formalin 2 grm. Add 1 or 2 c.cm. of sulphuric ether and shake strongly to detach the residue. Centrifuge for thirty seconds at

* This subdivision contains (1) Collecting Objects, including Culture Processes; (2) Preparing Objects; (3) Cutting, including Embedding and Microtomes; (4) Staining and Injecting; (5) Mounting, including slides, preservative fluids, etc.; (6) Miscellaneous.

† C.R. Soc. Biol. Paris, lxxx. (1917) pp. 435–7.

‡ C.R. Soc. Biol. Paris, lxxx. (1917) pp. 402–3.

1,800 revolutions per minute. Throw away the supernatant liquid, leaving the residue as before. This residue is now free from fat, blood corpuscles, and a great part of the bacteria, and contains only protozoal cysts, oocysts, helminth eggs, and food debris of high density. The residue may be taken up with the capillary pipette, mixed with double strength lugol solution and examined under the Microscope.

Two Rapid Methods for Searching for Malarial Crescents.*—L. Triboundeau and J. Dubreuil describe the two following methods for the rapid identification of malarial crescents in blood films :—1. Puncture the lobe of the patient's ear and take up several drops of blood with a capillary pipette ; transfer directly into a mixture of absolute alcohol 10 parts and distilled water 20 parts. Mix well by shaking. When the blood is hæmolyzed, centrifuge. Decant and reject the supernatant fluid. Centrifuge again and emulsify the residuum in a little of the liquid that collects at the bottom. Spread the emulsion on slides and allow to dry. Fix with alcohol and stain for about ten seconds with ammoniacal polychrome-blue (Triboudeau and Dubreuil). 2. Place a large drop of blood upon a slide at one extremity. Incline the slide and draw the blood along the slide, by means of a rod, to the other extremity. Place flat, in order to obtain an even layer of blood, and dry in the air without warming. Dehæmaglobinize and sprinkle with 1 in 3 alcohol, renewed several times. Fix with alcohol and stain as above. Examine the preparations with the oil-immersion lens. The leucocytes, with their blue nuclei, can be clearly seen, standing out against a background of lysed-red cells. The crescents are easily recognized by their masses of brownish-black pigment and by their characteristic shape.

Nematode Technique.†—T. B. Magath, in No. 77 of the "Contributions from the Zoological Laboratory of the University of Illinois," gives an excellent account of his own experiences and the results of other workers in obtaining success by means of careful technique. The paper is illustrated by six diagrams of various apparatus which the author has found useful.

(4) Staining and Injecting.

Distilled Water for Microscopical Stains.‡—L. Tribondeau points out that absolutely pure and neutral distilled water should only be used in staining by Leishman, Giemsa, etc. In testing the reaction of water for such purpose, one drop of an aqueous (1/100) solution of helianthin should be employed. If the colour obtained is orange or rose, the water is acid ; if the tint is yellow, the water is neutral or alkaline. In order to recognize alkalinity one adds, little by little, to a vessel containing water tinted yellow with a drop of helianthin, sufficient sulphuric acid solution (½ grm. to the litre) to produce a pale orange coloration. Add

* C.R. Soc. Biol. Paris, lxxx. (1917) pp. 494–5.
† Trans. Amer. Micr. Soc., xxxv. (1916) pp. 245–56 (6 figs.).
‡ C.R. Soc. Biol. Paris, lxxx. (1917) pp. 388–9.

the suspected water. If no change takes place the water is neutral; if a yellow colour is produced the water is alkaline.

Vital Staining of Malarial Parasites.*—A. Manaud suggests the use of Borrel's blue or methylen-blue for vital staining of malarial parasites. Deposit a drop of the colouring matter upon a slide, and allow to dry. Place upon a cover-slip a drop of the suspected blood. Place the cover-slip upon the slide and lute with paraffin. Leucocytes, etc., stain blue, with strongly staining nucleus. Chromotophyllic red cells also stain blue. On some of the cells one observes a blue spot containing yellowish-black pigment, occupying a part or the whole of the surface. The blue spot is darker at certain points, which may be situated at the centre or at the periphery. This appearance is said to be characteristic of the parasite. Basophile red cells are distinguished by the regularity of their staining and by their circular outline. The method is especially to be recommended for the observation of free forms of the parasite after crisis.

Biebrich Scarlet as a Plasma Stain.†—A. K. Gordon states that Biebrich scarlet is freely soluble in water, and is best used in 1 p.c. solution. It never overstains, and does not discharge the colour from nuclei. Most sections are stained sufficiently in from two to five minutes. It does not wash out in alcohol, clove-oil, cedarwood-oil, or xylol. It stains different tissues with varying degrees of shade and tint. Muscle, for example, is stained in yellowish-brown, the protoplasm of young epithelial cells a bluish-pink, and the older keratinized cells bright scarlet. Used after methylen-blue for tissues that have been fixed in Flemming's or Zenker's fluid it does not discharge the nuclear stain. The staining is of marked permanency.

The preparation is made by British Dyes, Ltd., Huddersfield.

Metallography, etc.

Wire-drawing.‡—A. T. Adam gives a brief description of the operations involved in drawing metal into wire, chiefly with reference to steel, and of the changes in properties and structure which the metal undergoes. There is an extraordinary increase in tensile strength and elasticity, but hardness and brittleness do not increase in the same proportion. The hardening effect sets a limit to the reduction in diameter which can be effected without annealing. An annealing at quite low temperatures removes cold work, but the best quality wires are heated to temperatures above the transformation temperatures, the conditions of annealing being designed to produce a sorbitic structure which is tougher and considered more suitable for drawing than a pearlitic structure. Observations upon the microstructure of steel-wires con-

* C.R. Soc. Biol. Paris, lxxx. (1917) pp. 472–4.
† Brit. Med. Journ., June 16, 1917, p. 828.
‡ Journ. Soc. Chem. Industry, xxxvi. (1917) No. 5, pp. 241–3.

sidered together with their properties accord with the amorphous cement theory. Cold drawing elongates the crystalline grains owing to plastic deformation, so that the structure appears fibrous. The slipping along cleavage planes within each grain which occurs during deformation decrystallizes the material along the internal surfaces of movement. These amorphous layers are harder and stronger than the crystalline material from which they are formed. When the rigidity of the metal is decreased by heating, recrystallization of the amorphous material takes place with consequent softening of the metal.

Influence of Arsenic on Brass.*—With the object of determining to what extent arsenical copper such as scrap shell driving bands could be used in the manufacture of brass, the influence of arsenic on brass has been studied in detail by O. Smalley. The alloys examined consisted of α and $\alpha\beta$ brasses with arsenic varying in amount from 0 to 1·0 p.c. In the case of the $\alpha\beta$ brasses, while the strength and hardness are practically unaffected, there is a serious drop in ductility in both the cast and hot-rolled states as the arsenic content rises. This is particularly marked in regard to the alternating impact number, which shows a very sudden drop with but small amounts of arsenic. Comparing the results of mechanical tests for the cast and hot-worked states, while hot-working non-arsenical $\alpha\beta$ brass raises the ductility and impact number without imparing the tenacity, the effect on arsenical $\alpha\beta$ brasses is to lower the ductility considerably and raise the tenacity only slightly. The embrittling effect of arsenic on $\alpha\beta$ brass is due to its existence in the brass as a brittle arsenide, seen in the microstructure as granules distributed in chain-like fashion mainly in the β constituent.

In the case of the cast α brasses, those with small amounts of arsenic (under 0·10 p.c.) show superior mechanical qualities to the non-arsenical brass. Further increase in the arsenic content reduces the elongation and shock-resisting properties considerably. All the cast alloys, however, were easily cold-rolled. The effect of cold-working and subsequent annealing causes an all-round improvement in properties up to 0·5 p.c. arsenic. Photomicrographs of arsenical α brasses in the cast, cold-worked and annealed states are given and described. It has been shown that copper arsenide is soluble in the α phase, but its solubility is dependent upon the rate at which the alloy is cooled, and the improvement in all-round properties of alloys containing 0·2–0·5 p.c. arsenic after cold working and annealing is due to the passage of residual free arsenide into solution. When the arsenic content exceeds 0·5 p.c. it is able to exert its individual embrittling effect, even although in solution. The ease with which cast α brasses can be cold-rolled, despite the presence of granules of brittle arsenide, is explained by the readiness with which the ductile α phase accommodates itself to plastic deformation. The temperature of annealing for arsenical brasses is 30°–50° higher than for similar non-arsenical brasses.

For etching arsenical brasses, a double attack was found to give more satisfactory results than attack by a single re-agent. After cleaning the polished surface from grease and dirt, it is immersed in a solution con-

* Journ. Soc. Chem. Industry, xxxvi. (1917) No. 8, pp. 429–39 (16 figs.).

sisting of potassium bichromate 40 grm., sulphuric acid (sp. gr. 1·84) 1 c.cm., water 100 c.cm., until a slight attack is visible to the naked eye; then rinse in water and immerse in a dilute acid ferric-chloride solution till a faint coloured film is seen to cover specimen; withdraw at once, wash with water, and dry with alcohol.

Use of Titanium in Steel-making.*—An exposition, accompanied by microphotographs, of the use and value of titanium as a deoxidiser and cleanser in removing harmful occluded gases and slags in steel-making is given by W. A. Janssen. It is added to the steel in the form of ferro-titanium, and is usually employed to augment the deoxidation begun by additions of ferro-silicon or ferro-manganese. Besides having a high affinity for oxygen, titanium has the additional advantages over other deoxidisers in the fusibility of the titanic oxide formed, also in the fact that it readily combines with nitrogen at 800° C. to form a stable nitride, which usually rises into the slag. Microscopical examination sometimes reveals the presence of titanium nitride in steel as tiny, hard, pink crystals, which, however, are less harmful than occluded nitrogen. Titanium does not alloy with steel; the results of many analyses of titanium-treated steels never showed a titanium-content higher than 0·025 p.c.

Bibliography of Alloy Systems.†—A complete list, with literature references, of all binary, ternary, and quaternary alloy systems whose equilibra have been investigated by microscopical, thermal or other means, up to January 1917, has been prepared by C. Estes. The list includes practically all the binary systems of the common metals, and a large number of the rarer metals—about sixty ternary and several quaternary systems. A bibliography of investigations into the allotropic modifications of metals is also added.

Determination of Grain-size of Annealed Brass.‡—The standardization of grain-size is recommended by G. A. Miller for controlling the quality of annealed brass obtained from different sources. He describes a method of measurement by comparison with a series of ten carefully prepared standard photomicrographs varying in grain-size from 0·025 mm. to 0·180 mm. These standards are prepared by counting the grains within a definite area on a clear print, averaging the counts of five different observers. The comparison is effected most speedily and accurately by throwing the image of the structure to be measured on the ground-glass screen of the photomicrographic apparatus, and comparing with equally illuminated lantern-slides of the standards, placed in a frame also attached to the photomicrographic apparatus. Check-measurements by different observers made thus did not vary by more than 0·005 mm.

* Foundry, xlv. (1917) No. 293, pp. 15–19 (9 figs.).
† Met. and Chem. Engineering, xvi. (1917) No. 5, pp. 273–82.
‡ Met. and Chem. Engineering, xvi. (1917) No. 7, pp. 378–80 (2 figs.).

PROCEEDINGS OF THE SOCIETY.

AN ORDINARY MEETING

OF THE SOCIETY WAS HELD AT 20 HANOVER SQUARE, W., ON WEDNESDAY, JUNE 20TH, 1917, MR. E. HERON-ALLEN, F.L.S., F.Z.S., ETC., PRESIDENT, IN THE CHAIR.

The Minutes of the last Meeting, having been circulated, were taken as read, approved, and signed by the President.

The President intimated that there were no Fellowship candidates to be balloted for, a circumstance which had not occurred for a great many meetings.

Mr. Martin Duncan then communicated a "Note on Fertilization and Deposition of Ova in *Portunus depurator*," in which he stated that he had recently been able to observe the repeated deposition of fertile ova by a female crab, after one copulation.

The first batch of ova were deposited attached to each other in typical manner. Subsequent depositions of the ova were separated from each other and rested on floor of tank like grains of sand. Every care was taken to preclude possibility of free spermatozoa being present in the water of the tank containing the female crab. This rarely observed phenomenon had been confirmed by Dr. H. C. Williamson and Mr. H. J. Waddington.

The President did not consider that the question of the presence of spermatozoa was of prime importance in the matter, because of the experiments of Dorothy Jordan Lloyd upon the unfertilized eggs of female *Echini* which had been kept, from birth, in sea-water passed through a Berkefeld filter, so excluding the faintest possibility of external agency. By exciting those eggs with hypertonic solutions, she succeeded in producing Echinoderm larvæ which reached the pluteus stage and developed into microscopic Echinoderms. Her results appeared in the "Proceedings" of the Royal Society; and her experiments were checked and repeated by Prof. McBride at the Imperial College of Science. Hence it was known that parthenogenetic eggs could be fertilized, and he asked whether it did not occur to Mr. Martin Duncan that a similar process was possible in the case of his eggs of *Portunus depurator*.

Mr. Martin Duncan, in reply to a question, said the second and third depositions were small in comparison with the first. Each subsequent deposit yielded a smaller number. He considered the President's suggestion was quite possible.

The President then called on Mr. Arthur Earland to read their joint paper "On *Nouria rugosa*: a new Foraminifer from the Shetland-Faroe Channel."

Mr. Earland stated that it had been intended to illustrate the note by direct enlargements of the actual specimen thrown on the small screen, but since the opening of the Meeting Mr. Barnard had informed him that he was not satisfied with the results obtained. He should, therefore, be compelled to fall back on the few lantern slides which had been prepared from the specimen.

The genus *Nouria* was instituted by the authors in 1914 for the reception of some tropical and sub-tropical Lituoline Foraminifera isomorphous in structure with the perforate genus *Polymorphina*. Subsequently a specimen was obtained from the Faroe side of the Shetland-Faroe Channel which presented the characteristic features of the genus, but differed from the previously described species. *Nouria rugosa* is 2 mm. in length and constructs a polythalamous shell of minute siliceous sponge spicules. They are all of uniform size, about 0·1 mm. in length, and of curved *Oxea* type. Considerable ingenuity is shown in the construction of the shell, the spicules being regularly arranged with the convex edge of one fitting into the concavity of the next. This necessitates a frequent change of direction in the arrangement of the spicules, and the intervening gaps are filled up with spicules singly or in tufts, arranged with points projecting from the surface. A certain amount of foreign material, megascleres, foraminiferous shells, &c., is also utilized in the construction of the test, but although these particles are very noticeable owing to their size they play a minor part in the construction. The sponge from which the spicules are derived has not as yet been identified.

After the paper had been taken, **Mr. Barnard** said that he was prepared to show a few direct enlargements of Foraminifera on the small screen as an experiment.

It was agreed that the results were very satisfactory, although the small size of the image and the weak illumination left room for further experiment and improvement.

The President announced that the next Meeting would be held on October 17th.

The Rooms of the Society will be closed from August 18th to September 17th.

The following Specimens were exhibited:—

Mr. F. Martin Duncan:—*Portunus depurator.*

Segmenting ova from a second deposition, early stage;
Segmenting ova from a third deposition, last stage;
Protozoœa developed from a second deposition of ova;
Zoœa developed from a third deposition of ova; and a
Series of photographs showing female *Portunus* with ova, and special organs to which the masses of ova are attached.

Messrs. E. Heron-Allen and A. Earland:—

Nouria rugosa, H.-A. & E., type specimen.
N. polymorphinoides, H.-A. & E., from the Kerimba Archipelago, East Africa.
N. harrisii, H.-A. & E., and
N. compressa, H.-A. & E., from the Philippine Islands.
Carterina spiculotesta (Carter) from the Kerimba Archipelago, East Africa.

JOURNAL

OF THE

ROYAL MICROSCOPICAL SOCIETY.

OCTOBER, 1917.

TRANSACTIONS OF THE SOCIETY.

VIII.—*Alcide d'Orbigny, his Life and his Work.*

By Edward Heron-Allen, F.L.S. P.R.M.S.

Errata and Corrigenda.

The Memoir published under the above title in the current volume of the Journal of the Royal Microscopical Society (1917, pp. 1–105) has been translated, by permission of the Council, for publication in the "Bulletin du Muséum National d'Histoire Naturelle," by a French scientist. Since the publication of the Memoir I have been in correspondence with several members of the d'Orbigny family, with the translator, and with other readers, who have called my attention to a few errors, for which the sources of my work were responsible, and have suggested one or two alterations which I am happy to adopt. Besides these, my attention has been drawn to one or two misprints which, in spite of careful proof-reading, escaped me. I take this opportunity of recording these Corrigenda in the current volume.

Page 4, note 1, line 4—for *Ile* read *Ille*.
Page 5, line 32—delete *of him and.*
" 33—for *Rue d'Orbigny* read *Rue Alcide d'Orbigny.*
Page 9, note 2, line 3—transpose (*1*) and (*2*).
" " 7—for *G. Perrier* read *A. Périer*.
Page 66, par. 3—Prof. d'Arcy W. Thompson, F.R.S., writes me :—" You quote the date of the second volume as 1852. My copy has two separate title-pages, for the two facsimiles of the second volume, and they are dated 1851 and 1852 respectively." Both title-pages in my copy are dated 1852, and the " Prodrome " is quoted as being already published on p. 11 of the first facsimile.

Page 70, line 8—for *Daman* read *Damour*.
Page 73, par. 1—Mr. F. Chapman calls my attention to the fact that the "Silurian Clay with glauconitic casts" (see his "Foraminifera," 1902, p. 253) "is now known to belong to the Lower Cambrian, for it underlies the Olenellus beds . . . so that their history dates back many millions of years prior to the Silurian."
Page 87, line 6—after *Dessalines* insert (*or Des Salines*).
Page 88, line 9—for *1880* read *1800*.
,, ,, 4 from bottom of page—after *d'Appel* insert (*Paris*).

The re-publication of the curious legend that d'Orbigny was a descendant of the rebel Dessalines, and that Dessalines was the slave of a black potter of that name, gives pain to the d'Orbigny family, and will be suppressed in the translation. I considered it proper to give the information, which has been invested with the authority of Larousse, but I think that the dates which I have given are enough to disprove the possibility of Charles d'Orbigny being in any way related to the notorious Dessalines.

SUMMARY OF CURRENT RESEARCHES

RELATING TO

ZOOLOGY AND BOTANY

(PRINCIPALLY INVERTEBRATA AND CRYPTOGAMIA),

MICROSCOPY, ETC.*

ZOOLOGY.

VERTEBRATA.

a. Embryology.†

Cyclic Changes in Mammalian Ovary.‡—Leo Loeb finds that rabbit and ferret do not show cyclic changes in the follicular apparatus of the ovaries, comparable to those he previously described in the guinea-pig. The guinea-pig's ovary has no interstitial gland like that of rabbit and ferret. In the guinea-pig during heat a spontaneous ovulation occurs, not depending on preceding copulation. In rabbit and ferret copulation is necessary, as well as heat, to ensure ovulation. During the winter the ovaries of the ferret are small, but the interstitial gland is well preserved.

Cyclic Changes in Mammary Gland of Guinea-pig.§ — Cora Hesselberg and Leo Loeb find that the normal sex-cycle of the guinea-

* The Society are not intended to be denoted by the editorial "we," and they do not hold themselves responsible for the views of the authors of the papers noted, nor for any claim to novelty or otherwise made by them. The object of this part of the Journal is to present a summary of the papers *as actually published*, and to describe and illustrate Instruments, Apparatus, etc., which are either new or have not been previously described in this country.

† This section includes not only papers relating to Embryology properly so called, but also those dealing with Evolution, Development, Reproduction, and allied subjects.

‡ Proc. Soc. Exper. Biol. Med.. xiii. (1916) pp. 162–4. See Physiol. Abstracts, i. (1916) No. 8, p. 365.

§ Proc. Soc. Exper. Biol. Med., xiii. (1916), pp. 164–6. See Physiol. Abstracts, i. (1916) No. 8, p. 365.

pig lasts sixteen to eighteen days, and that the mammary gland shows two phases in this cycle. The first, depending upon the absence of the corpus luteum and the activity of another constituent of the ovaries, is marked by proliferation. In the second, proliferation is as a rule absent, though it may occur towards the end of the phase; it is probably due to substances secreted by the corpus luteum.

Can Artificially-activated Eggs be Fertilized?*—C. R. Moore has experimented with eggs where artificial activation has been complete, as indicated by membrane formation and the absence of Lillie's fertilizin. In such cases the superposition of fertilization is impossible. Where the activation has been only partial, a partial fertilization may be effected, but development in such a case is not normal.

Growth and Form.†—D'Arcy Wentworth Thompson has made an important contribution to Bio-physics, and his book touches at many points the interests of the microscopist. It is an application of some of the concepts of physical science and sundry mathematical methods to the study of organic form. A beginning is made with Galileo's "principle of similitude," that "neither can man build a house nor can Nature construct an animal beyond a certain size, while retaining the same proportions and employing the same materials as sufficed in the case of a smaller structure." Differences in degree of magnitude are associated with profound differences of physical property and potentiality.

The rate of growth is the subject of a long discussion, for the form of an organism is usually a direct expression of a rate of growth which varies according to its different directions. The velocities in different directions tend to maintain a *ratio* which is more or less constant for each specific organism; and to this regularity is due the fact that the form of the organism is in general regular.

There is a long and fascinating discussion of the bio-physics of the cell, which is treated as a sphere of action of certain more or less localized forces, of which surface-tension is the one especially responsible for giving the cell its outline and its morphological individuality. The author seeks to show that cell-division and other intra-cellular phenomena may be tentatively explained as the results of a conflict between surface-tension and its opposing forces. The phenomena of karyokinesis are analagous to, if not identical with, those of a bipolar electrical field. The forms of free cells are essentially dependent on surface-tension, and that along with the laws of equilibrium and the principle of minimal areas may be said to go far in interpreting the forms of cells in aggregates or tissues.

It is pointed out that all possible groupings or arrangements whatsoever of eight cells, none being submerged or wholly enveloped, are referable to one or other of thirteen types or forms, or perhaps fewer, since some are unstable.

A very interesting chapter discusses concretions, spicules, and spicular

* Biological Bulletin, xxxi. (1916) pp. 137–80.
† On Growth and Form. Cambridge: 1917, xv and 793 pp.

skeletons. The form of the spicule may depend simply on its chemical nature; or the inorganic solid material may be laid down in conformity with the shapes of the cells and tissues; or there may be intermediate cases where the molecular forces play their part in conjunction with, and under the restraint of, the other forces inherent in the system.

Other chapters deal with the widespread occurrence of the logarithmic spiral, with shapes of shells and eggs, with adaptations of minute architecture, as in bone, to mechanical efficiency, and with the passage from one shape to another as the result of a simple harmonious deformation. The author has shown what promise there is in the endeavour to carry into the study of organisms the laws and lessons of the inorganic.

Development of Hypophysis and Related Structures in Marsupials.*—Katherine M. Parker finds in *Bettongia*, *Macropus*, *Perameles*, and *Trichosurus* a pair of head-cavities whose early relations and subsequent history show them to be premandibular somites. In *Perameles* these structures arise from a prechordal plate which represents a derivative of the antero-dorsal wall of the fore-gut. A well-developed Seessel's pocket or pre-oral gut occurs in some Marsupials; in *Phascolarctos cinereus* and *Phascolomys mitchelli* it forms a constituent part of the hypophysis.

The primitive relation of the tip of the notochord is one of continuity with the protochordal plate, and in *Perameles* continuity is retained between the chorda and the derivatives of the protochordal plate (prechordal plate and Seessel's pocket). As a secondary condition, continuity may be established between the chorda and the hypophysis.

The development of Ratke's pouch is due to rapid growth of the differentiated epithelium of the hypophysial angle, and not to any mechanical power exercised by the chorda or any other structure. From Ratke's pouch in Marsupials there arises a proximal lobe, at the point of junction of the duct with the body of the pouch. This forms the pars tuberalis of the adult pituitary body.

The glandular structure of the pars distalis (anterior lobe) of the adult is produced either by outgrowth of processes from the walls of Ratke's pouch or by ingrowth of connective tissue into the thickened walls of that structure. Two types of cells, "chromophilic" and "chromophobic," are differentiated *in situ* in the pars buccalis before the adult condition is fully reached. The pars neuralis arises as a hollow conical outgrowth of the diencephalic floor. It is gradually transformed into a solid, swollen lobe, and is then penetrated by connective tissue.

Ossification in Ovary.†—Eli Moschcowitz describes three cases of calcification and two cases of ossification in the human ovary. The process in each case involved a corpus albicans. Four stages are recognizable: (1) an early discrete multiple deposit within a healed corpus luteum; (2) a definitely circumscribed deposit of amorphous lime within a corpus albicans; (3) the formation of primary Haversian

* Journ. Anat., li. (1917) pp. 181–249 (42 figs.).
† Johns Hopkins Hospital Bull., xxvii. (1916) pp. 71–8 (4 pls.).

canals, accomplished by the genesis of active mesoblastic tissues on and within the lime deposit, the mesoblastic tissue being derived from adjacent blood-vessels of the ovary; and (4) true bone formation with marrow. Blood-vessels, osteoblasts, bone-cells, and marrow (in large part, at least), are merely differentiations of the mesenchymal cell unit. The histological constituents of the new blood-vessels are the progenitors of all the histological components of the osseous tissue. The cases tell against the theory of the specificity of endothelium, and favour the adaptive or mesenchymal theory. Ossification does not occur without preliminary calcification, and calcification occurs only in dead tissues. There is no valid reason for regarding bony structures within the ovary as blastomata.

Bone Formation in Ovary.*—G. W. Outerbridge describes a number of cases in which true bone developed in the ovary, independently of neoplastic or teratomatous processes, in most if not all cases in corpora fibrosa.

Dwarf-eggs of Domestic Fowl.†—Raymond Pearl and Maynie R. Curtis have studied the production of dwarf-eggs in the domestic fowl. They find two distinct types of shape, a prolate spheroidal and a cylindrical, the latter being infrequent. Thirty-five per cent of the eggs examined were yolkless; the rest contained yolk, but only in 9 p.c. of these was there an enclosing membrane. The production of a dwarf-egg is usually an isolated phenomenon, occurring only once or twice in the lifetime of a bird, and in most cases the occurrence is not correlated with a morphological disturbance of the sex-organs. In eleven out of two hundred cases, however, no normal eggs were produced after the dwarf-egg, and examination showed, in five of these, some pathological condition of the oviduct which interfered with the passage of the egg. In normal birds dwarf-egg production occurs during the height of the breeding season, and is not associated with immaturity. Dwarf-eggs may be produced by stimulation of an active duct by some material which is not yolk, but at least 65 p.c. of those studied were initiated by an abnormal small yolk, or by part of a normal yolk, the rest evidently being absorbed by the visceral peritoneum.

The Term "Factor."‡—Howard B. Frost points out that the term "factor" has, in genetic use, two distinct meanings, which are continually interchanged or combined, and often confused. It is essential to clearness in genetic discussion that these two meanings should be carefully distinguished. The following formal definitions are suggested: 1. A genetic (Mendelian) factor is a property or characteristic of the germ-plasm, more or less conveniently delimited for the purpose of analysis of segregating heredity. 2. A genetic (Mendelian) factor, or

* Amer. Journ. Med. Sci., cli. (1916) pp. 868–87. See Physiol. Abstracts, i. (1916) No. 7, p. 286.

† Rep. Maine Agric. Exper. Stat., 1916, pp. 289–328.

‡ Amer. Nat., li. (1917) pp. 244–50.

gene, is an actual material unit of genetic segregation ; it is of unknown nature, but probably consists of a genetically indivisible portion of a chromosome (a *locus*) in a particular state. The presence-and-absence scheme of factor notation properly employs only the first of these meanings ; the Morgan-Castle scheme, on the other hand, may use either.

Control of Sex-ratio.*—Oscar Riddle distinguishes two questions : "Has a particular germ-cell which had initial tendencies to produce one sex been experimentally forced to the production of the opposite sex ?" and "Have the conditions of the experiment decreased or suppressed the production, or hindered the union, or modified the chromosomal constitution of one of the types of germ-cell and left the other normal and functional ?" These possibilities of accounting for abnormal sex-ratios certainly exist, and they must be squarely met by decisive experiment.

In some animals (e.g. insects and several mammals) one and the same male produces spermatozoa of two kinds, which are not equal in their prospective sex-value. In other types (e.g. moths and birds) the female produces two kinds of eggs, having opposite prospective sex value. In parthenogenetic forms, such as bee, gall-fly, plant-louse, the sex is known to bear certain relations to chromosome number or to maturation phenomena in the egg. In wide crosses among Echinoderms, Baltzer and Tennent have shown that when the cross is made in one of the two possible directions, some of the chromosomes proceeding from the sperms are eliminated and do not take part in embryo-formation. This type of chromosome behaviour has been found, however, only in crosses of very widely-separated forms.

Pure wild species of doves and pigeons have proved to be almost ideal material for obtaining highly abnormal sex-ratios, and for the analysis of the significance of the modified ratios. Whitman showed (1) that generic crosses, when not permitted to lay many eggs, produce mostly or only males ; (2) that such pairs, when made to lay many eggs (crowded reproduction), produce males predominantly from their earlier, stronger eggs, and predominantly or only females from the later eggs laid under stress of overwork ; and (3) that from eggs of pure wild species the first egg of the pair or clutch more often hatches a male ; the second egg of the pair more often produces a female.

Riddle finds that the ova of the pigeon are certainly sexually dimorphic. Nearly 900 individual yolks have been analysed, to determine whether chemical differences are discoverable between male-producing and female-producing ova. It was found (1) that the male-producing egg of the spring is an egg that *stores* less material than does the female-producing egg of the autumn ; (2) that the male-producing egg of the clutch *stores* less material than does its female-producing mate ; (3) that the eggs of old females *store* more material and yield a higher percentage of females than those of birds not old. Thus it is evident that the egg of female-producing tendency is one whose *storage* metabolism is high, as compared with eggs of male-producing tendency. Moreover, the analyses show that during the season successive clutches

* Journ. Washington Acad. Sci., vii. (1917) pp. 319-56.

present higher and higher storage, i.e. the earlier clutches store less—are more male-like; the later ones all store more—are more female-like; and the eggs of the low-storage period give rise (in the generic cross) to males, and those of the high-storage period produce females.

"The progressive *increase* in *storage* capacity of the eggs during the season—under overwork—is to be interpreted as a *decrease* in the *oxidizing* capacity of these same eggs. Living cells in general dispose of ingested food material by storing it or by burning it. If oxidized, the products of the oxidation are removable, and do not serve to increase the bulk of the cell. The *low-storage capacity* of the male-producing eggs as compared with the *high-storage capacity* of female-producing eggs, is therefore, an index of *higher oxidizing capacity*, or, as more usually stated, a *higher metabolism* of the male-producing eggs as compared with the female-producing eggs." There is also some evidence (with exceptions) that the male-producing ovum has a higher percentage of water than does the female-producing ovum, and it is plain that the more hydrated state of the colloids favours a higher rate of oxidizing metabolism, while the less hydrated state favours increased storage.

An estimate of energy-values of the yolks, determined by the calorimeter, confirms the conclusions otherwise reached. Curious corroborations are also afforded by studies in sex-behaviour. Thus, females hatched from eggs laid earlier in the season are more masculine in their sex-behaviour than are their own full sisters hatched later in the season. Several grades of females can be thus seriated according to the season of hatching. The female hatched from the first egg of the clutch is more masculine than her sister hatched from the second of the clutch in a great majority of cases. Another curious point is the frequency in the persistence of the right ovary in birds hatched from eggs otherwise known to be most feminine.

There is clear evidence that sex and such characteristics as fertility and developmental energy not only bear initial relations to the order of the egg in the clutch, but that sex and these other characteristics are *progressively modified* under stress of *reproductive overwork*, until at the extreme end of the season certain feminine features are abnormally or unusually accentuated. Thus sex reveals itself as a quantitative modifiable character, associated with modifiable metabolic levels. Femaleness in the egg is associated with low metabolism, lower percentage of water, and higher total of fat and phosphorus, or of phosphatides; and conversely for maleness. Analyses of the blood of adult birds go to show that the metabolic differences of male and female germs persist in the male and female adults.

The agreement between Riddle's experimental results and the interpretations offered by Geddes and Thomson in "The Evolution of Sex" (1889) is remarkable. The author writes: "A general classification of male and female adult animals on the basis of a higher metabolism for the one and a lower for the other, was indeed made by Geddes and Thomson many years ago. It now seems beyond question that this conclusion of these authors is a correct and important one."

The author refers to the fact that the extent of the modifiability of an animal by internal secretions, which modify the metabolism, is, in general, proportional to the immaturity of the treated animal. He finds corroboration of his views in the beautiful experiments of Baltzer on the worm *Bonellia*. The newly-hatched larvæ are capable of becoming either males or females. "If they happen to become attached to the proboscis of an adult female they become males ; if they do not succeed in so attaching themselves they soon settle from the water into the sand or mud of the sea-bottom, and there undergo, quite slowly, further development into *females* (almost exclusively). The plastic, reversible, quantitative nature of sex in this form was shown by this investigator in the following way : Some of the free-swimming "indifferent" larvæ were artificially helped to a connexion with the proboscis of an adult female. Some of these were permitted to maintain this attachment for a very short period ; others were removed at progressively longer periods, with the very significant result that practically all stages of hermaphroditism were produced, those first removed becoming almost perfect females, others with longer and longer periods of attachment becoming more and more perfect males."

The general idea based on the author's experiments is that sexually-differentiated organisms have had, from the first, the problem of producing germs pitched at two different metabolic levels. In connexion therewith the germ-cells have in some cases established two different chromosome complexes. But the requisite metabolic level of the germ may be established in the absence of the appropriate chromosome complex, and the sex of the offspring made to correspond with the acquired grade or level of metabolism. "Most important of all, perhaps, is the demonstration that one *hereditary* character is modifiable, is of a fluid, quantitative, reversible nature. Seemingly this can only mean that other hereditary characters are also modifiable."

Reproductive Processes in Birds.*—Oscar Riddle and others have made diverse studies on the reproductive processes in birds. Riddle finds that when the oocyte of the fowl reaches a diameter of 6 mm. the ratio of growth suddenly (within a day) increases twenty-five fold. The same is observed in other birds and in reptiles. The increase is chiefly in the yellow yolk, and is accompanied by changes in the growth and activity of the follicular membrane.

Adelaide A. Spohn and O. Riddle find that in the fowl and the pigeon the yolk begins to absorb water from the white as soon as it leaves the ovary. The white yolk has a higher water value, is more like embryonic tissue, and is in immediate contact with the embryo.

Riddle finds that after the twelfth day of incubation the phosphatides of the yolk (20·6 p.c.) are utilized more than the neutral fats (49·5 p.c.), and these faster than the protein (28·4 p.c.).

O. Riddle and A. A. Spohn find that the albumin secreted by the oviducal glands at first is not an exact equivalent of that formed later, differing chiefly as regards the proportion of water to solids.

O. Riddle and G. C. Basset find that alcohol given by inhalation over

* Amer. Journ. Physiol., xi. (1916) pp. 387–437. See Physiological Abstracts, i. (1916) No. 9, pp. 423–4.

prolonged periods reduces the size of the yolk, and the effect persists for weeks or months.

J. V. Lawrence and O. Riddle find that there are differences in the fat and phosphorus metabolism of male-producing and female-producing ova. In the adult female the blood-plasma is richer in alcohol-soluble substance and phosphorus than in the adult male, and this increases during sexual activity. The initial metabolic difference in the two kinds of eggs thus persists in the organisms that develop therefrom.

Breeding Habits of the Midwife-toad.*—G. A. Boulenger contrasts some of Kammerer's statements on the breeding habits of *Alytes obstetricans* with his own observations, which confirm on all important points those of de l'Isle. Kammerer supports the old belief, originating with Demours in the eighteenth century, that the male toad pulls out the strings of eggs from the female, and thus performs an obstetric function. But according to the author, and to de l'Isle, who witnessed the whole process of parturition twenty-three times, the ova are expelled suddenly, in a second or two, forming a ball-like mass between the hind-legs of the couple, and the male does not attempt to disentangle the strings until after about ten minutes' rest. According to the author's observations there are two distinct phases in the operation, which he observed seven times—the first, ending with the extrusion of the eggs, during which the male clasps the female round the waist; the second, during which the male clings to the neck of the female, and proceeds with the fertilization and the movements of the hind limbs, by means of which the eggs are entwined round them. Another discrepancy between the results of the two investigators is in regard to oviposition in water. Kammerer says that if the eggs are laid in water the gelatinous capsules swell up, and thus lose their viscosity. The strings do not adhere in the normal manner to the hind-limbs of the male, and therefore remain lying in the water, but, notwithstanding this, some of the eggs develop. Boulenger's experience is different on both points. He finds that the eggs are normally subjected to considerable soaking with fluid from the bladder of the male during fecundation, and the swelling when they are placed in water is not very much increased, nor is the toughness and viscosity of the capsules diminished. In very shallow water the male should be able to deal with the strings in the usual way. Experiment showed that, if the eggs were left in water, development did not proceed beyond the fifth day. Boulenger admits that the great perfection to which Kammerer has brought his terrarium may account for his higher percentage of success in breeding, but in view of the difference between the Viennese observer's results and those of others—and, indeed, of the contradictoriness of some of Kammerer's own statements—he suggests that careful revision is necessary.

In regard to Kammerer's claim to have observed a structural variation in the fourth generation of the "water-form"—a black nuptial callosity on the "thumb" or inner finger—Boulenger quotes Bateson's

* Ann. Mag. Nat. Hist., xx. (1917) pp. 173-84.

challenge to Kammerer to produce more satisfactory evidence than the very inadequate figures on which he bases his claim to have proved Mendelian segregation in regard to an acquired character. No specimen having been furnished, the discussion of this important point must, says Bateson, await a repetition of the experiment. Boulenger's paper concludes with the suggestion that it was the large size of the eggs that enabled the ancestors of *Alytes* to take to oviposition on land, and not that the character of the eggs has been modified to that effect.

Sex and Heredity.*—R. Goldschmidt discusses some experiments which throw further light on the sex problem. He refers first to three outstanding facts :—1. Cytologically, one of the sexes, the heterogametic sex, contains only one X-chromosome ; the other, the homogametic sex, contains two. As the maturation-division separates entire chromosomes, the heterogametic sex produces two kinds of sex-cells, with and without X-chromosomes. But the homogametic sex produces only one kind, all with X-chromosomes. Chance fertilization produces again the two parental combinations, that is, the two sexes. 2. Mendelian experiments show that one sex is heterozygous for the sex-factors, say Ff ; the other homozygous, say FF ; the first one produces two kinds of gametes, the second only one. Chance fertilization results in equal numbers of the parental combinations. 3. Experiments on sex-limited inheritance have shown that the two sets of facts are the same, that the X-chromosomes are the vehicles for the distribution of the sex-factors. If we state, further, that there are animals in which the heterozygous sex is the female, and others in which it is the male, we know the elementary facts from which any further study of the sex-problem has to start.

But what are the sex-factors, and how do they determine sex ? Are the two sexes clean-cut alternatives, or are they nothing but limiting points of a series, which might approach each other or even become interchanged ? One line of approach to an answer is to be found in the study of the influence of the internal secretion of the sex-glands in castration and transplantation experiments. Another line is to be found in the study of sexual abnormalities in insects. Goldschmidt has worked with the gipsy-moth.

Crosses of Japanese females with European males yield normal off-spring ; the reciprocal cross yields normal males and females with admixtures of male characters. This gynandromorphism is called by the author intersexuality. It segregates, F_2 giving normal forms and intersexual forms. In some experiments the hybrid females are normal, the males become intersexual.

The explanation offered is the following :—Both sexes contain the primordia for either sex. In both sexes, irrespective of the constitution, both primordia might become patent. Which one is to appear depends entirely upon the quantitative relation of both. The female factorial set and the male factorial set act independently and with a definite quantitative strength, which may be called their potency or valency. It might mean a certain concentration of enzyme ; when the preponderance of one

* Amer. Nat., l. (1916) pp. 705–18.

set over the other falls below a certain minimum, intersexual forms result.

Some of the intersexual females are very remarkable, with the secondary sex-characters almost male, with instincts and behaviour intermediate, with external genital organs showing the strangest combinations, with typical but rudimentary ovaries. Others are externally almost indistinguishable from true males, but certain characters, especially in the copulatory organs, still show their female origin. The sex-instincts are entirely male. The gonad is like a testis, but shows in sections every single step between an ovary with nothing but immature eggs, through a mixture of ovarial and testicular tissue, to a real testis. This is the highest grade of intersexuality that can be reached. The next step would be the complete transformation of the would-be females into males. And by other crosses this is also obtainable. All this points to a quantitative conception of sex-determination.

The series of intersexual males extends almost to femaleness. In low grades the testis always contains some ovarial tissue. The highest grade, of almost female exterior, contained a paired gonad (the normal ripe testis is unpaired) of somewhat testis-like character, filled with giant bundles of apyrene spermatozoa, and containing no eggs.

Effect of Calcium Salts on Growth.*—Raymond Pearl gave growing chicks (29 to 171 days old) small daily doses of calcium lactate or of calcium lacto-phosphate. Male chicks were not affected; female chicks showed marked increase (especially in lacto-phosphate treatment) in the absolute amount of growth, and a corresponding acceleration in the rate of growth. The reproductive organs of the females were stimulated as well as growth. The rate of egg-production per unit of time in the female chicks dosed with lacto-phosphate was nearly five times as great as in the controls. If a small dose of corpus luteum substance be administered along with the calcium lacto-phosphate, the stimulating effect of the latter upon the growth of the females is completely inhibited.

Various gland substances have a differential effect on the growth of the two sexes. It is now shown that inorganic salts may have a differential effect. This furnishes one more piece of evidence of the deep-seated biochemical differences which underlie sex-differences. The experiments are also in line with others which show the importance of calcium in the physiology of the reproductive organs of the female.

Influence of Pituitary Feeding on Growth and Sex Development.†
Emil Goetsch has experimented with rats, and finds that pituitary extract (anterior lobe), given in food to young rats, has a stimulating effect upon the growth of the animal and upon its sexual development and activity. Posterior-lobe extract, when thus given, has a retarding influence. Ovarian extract (corpus luteum) has a stimulating influence

* Science, xliv. (1916) pp. 687–8.

† Bull. Johns Hopkins Hospital, xxvii. (1916) pp. 29–50 (4 pls.).

upon the female, and a retarding influence upon the male, as regards sexual development.

Fertility and Age.*—Raymond Pearl notes that in a variety of mammals the rate of fertility, starting at a low point, at the beginning of the sexual life, rises with advancing age to a maximum, and then declines with further increase in age, until total sterility is reached. In the domestic fowl he finds that there is a decline in net reproductive ability or fertility, as measured by the reproductive index, with advancing age in both sexes. The rate of the decline, however, is more rapid in the male than in the female. As contrasted with what is noted for mammals, there is a steady and progressive decline in fertility after the first breeding season. "There is a significant drop in reproductive ability as we pass from a combined age of two years for the mated birds to three years. In passing from three years to four there is no significant change in reproductive ability. In passing from a combined age of four years to that of five years, there is a large drop in the net reproductive ability of the mating."

Superfetation and Deferred Fertilization among Mice.†—F. B. Sumner, working with *Peromyscus maniculatus*, has made some interesting observations which point, with considerable probability, to two facts: (1) to a definite periodicity in ovulation, continuing in some cases throughout pregnancy; and (2), with even greater probability, to the retention by the spermatozoa of their fertilizing power for days, or even weeks, after reception into the uterus or fallopian tubes. The phenomena do not seem to be very rare. Most of the supernumerary litters comprised normally healthy animals. In four cases out of eight the parents of the supernumerary litters were both very young mice. The possibility suggests itself that some of the alleged cases of "telegony" may be due to the retention of spermatozoa received from an earlier mate. A later copulation with a different partner might happen to coincide with a conception in which the earlier insemination was really the effective one.

Correlation of Internal Secretion and Female Sex Functions.‡ W. Blair Bell has given a connected account of recent work by himself and others which goes to show that the reproductive functions are directed and controlled by all the organs of internal secretion acting together. The ovaries are to be considered as part of a system, to which most, if not all, the other endocritic (or ductless) glands belong, and in which these other organs in their relation to the reproductive functions figure with as great importance as the ovaries themselves. Besides producing ova, the ovaries produce an internal secretion or internal secretions, not yet isolated. The evidence rests upon the results of extirpation, destruction, and implantation experiments, and

* Proc. Nat. Acad. Sci., U.S.A., iii. (1917) pp. 354–6.
† Biol. Bull., xxx. (1916) pp. 271–85.
‡ The Sex Complex. London: 1916, xvii and 933 pp. (50 figs.).

to a lesser degree on clinical observations. The author states the effects of oöphorectomy on the pregnant and non-pregnant uterus, on the other ductless glands, and on the general metabolism. He discusses in succession the influence of thyroidectomy, removal of the parathyroids, removal or injury of the pituitary, thymectomy, and the removal of the suprarenals. He considers the relation of the pancreas to the other organs of internal secretion; the influence of various hormones, including those of the fœtus, on mammary activity.

The influence of the ovary on the general metabolism is related to and dependent on its primary reproductive functions. The thyroid, pituitary, and suprarenals influence the development and subsequently preserve the integrity and activity of the genitalia. Others—the thymus, and possibly the pineal—appear to prevent sexual precocity. Moreover, all the endocritic organs, acting in harmony, control the metabolism in response to the necessities of the genital functions; in addition, they adapt the whole organism to the needs of the situation, and regulate the secondary characteristics, both physical and psychical, to suit the requirements of the individual. Once, however, the reproductive organs are removed or undergo atrophy, the genital functions of the rest of the endocritic system cease, and the metabolism is readjusted. Contrariwise, insufficiency of the thyroid, pituitary, or suprarenals, may cause the cessation of the genital functions with atrophy of the uterus. The individual metabolism and the reproductive metabolism are absolutely interdependent. This thesis is then corroborated by evidence from pathological conditions.

Collar Cavities of Larval Amphioxus.*—K. M. Smith and H. G. Newth find that the space into which the right collar cavity opens as it sweeps downwards towards the mid-ventral line is the splanchnocœl, and not, as MacBride supposed, a distinct cavity lying external to the splanchnocœl, which later became the cavity of the atrial fold (van Wijhe's "pterygocœl"). MacBride † accepts the conclusion of the authors, whose material he has examined. A re-examination of his own preparations leads him to believe that the septum which he believed to divide the splanchnocœl from another cavity external to it is the parietal wall of the cœlom, which in the process of preparation had become separated from the ectoderm. The facts elucidated by Smith and Newth enable us to compare the collar cavity of *Amphioxus* directly with the mandibular cavity of the embryos of *Petromyzon* and the Elasmobranch embryo.

b. Histology.

Amitosis in Cells in Vitro.‡—C. C. Macklin has studied cultures of tissues from chick-embryos (two to ten days old). They were kept in

* Quart. Journ. Micr. Sci., lxii. (1917) pp. 243–51 (1 pl.).
† Quart. Journ. Micr. Sci., lxii. (1917) pp. 249–50.
‡ Biol. Bull., xxx. (1916) pp. 445–62.

Locke's solution. Amitosis occurred, involving the nucleus only, not the cell-body. Mitotic division of the binucleate cell sometimes followed the amitosis of the nucleus.

Chromosomes in Fowls.*—M. F. Guyer finds a large curved chromosome, which he regards as bivalent, in the primary spermatocytes of the testes. The same occurs in many cells of female embryos. The males are regarded as homozygous, and the females as heterozygous for sex and sex-linked characters.

Regeneration of Mesencephalon in Larval Amblystoma.†—H. Saxton Burr finds that regeneration of nervous tissue follows the removal of the right eye and the underlying mesencephalon. The tissue is similar to that normally found, except that important optic areas are lacking. Removal of the mesencephalon only, the eye being left, is followed by almost complete regeneration of the optic lobes. It is inferred that functional activity of the end-organ normally connected with the brain affords the necessary stimulus to regeneration of the part of the brain removed.

Histology of Poison-glands of Bufo agua.‡—P. G. Shipley and G. B. Wislocki distinguish in the skin of this tropical toad those glands which produce adrenalin and those whose secretion contains none of that substance. The adrenalin-producing acini are limited to the glandular masses behind the eye and surrounding the typanum, known as the "parotid" glands, the chromaffin reaction being negative in all other cutaneous glands. The contents of the poison-glands having been discharged, probably through the contraction of a smooth muscle-coat surrounding the gland acinus in response to a stimulus of sufficient strength, the emptied sac does not refill, but is resorbed, its place being taken by an immature gland of the same type. These young glands bud from the duct or neck of the older gland-sac, about which a ring of them may be found. They grow downward through the various strata of the cutis vera, carrying with them a layer of tissue from the outer loose layer of the dermis, and are surrounded by it throughout. The secretion of these poison-glands is produced by and during the destruction of the cytoplasm of epithelial elements lining the acinus of the young gland, the destruction leaving only a cell-nucleus within the acinar wall.

Two kinds of secretion occur in the lumen of the mature poison-gland :—1. A granular secretion, which is the first to be formed, and is found filling the entire lumen of the young glands, and is located in the central part of the mature acini. 2. A clear homogeneous or finely-punctate fluid filling the periphery of the lumen, which takes on a bright yellow colour after fixation in fluids containing chromates. This

* Biol. Bull., xxxi. (1916) pp. 221–68.
† Proc. Soc. Exper. Biol. Med., xiii. (1916) pp. 180–1. See Physiol. Abstracts, i. (1916) No. 8, p. 349.
‡ Carnegie Inst. Washington, Contributions to Embryology, iii. (1915) No. 9, pp. 73–90 (2 pls.).

chromaphil secretion is not found in the young glands, nor does it ever occur in cutaneous glands in other parts of the body. As the gland grows older without being used, the chromaphil secretion diffuses into the central part of the gland, so that the entire venom stains yellow with chromate solutions. The homogeneous liquid is the first secretion to reach the skin surface when the gland discharges in response to a stimulus, probably because it is less viscous than the granular secretion, and its appearance is followed by the ejection of the first or granular emulsion in the centre of the gland. In this way the adrenalin component of the gland-venom is the first poison to reach the mucous membranes of an attacking animal.

The adrenalin-content of the venom is not secreted as such by the glandular epithelium, since at no time in their history do the epithelial cells show any yellowing after treatment with chromate solutions, nor does the poison-sac contain chromaphil material until long after the disappearance of all epithelial elements. The adrenalin is probably the result of a change produced in a mother-substance, which is very likely an amino-acid, as Guggenheim first suggested, through the action of the naked nuclei of the old epithelial cells, which remain attached to the inner surface of the wall of the poison-sac. Analogous processes occurring elsewhere in nature suggest that the change in question may be a process of decarboylization, which results in the formation of this aromatic amin base from a corresponding acid.

There is no clue to the origin of the hypothetical amino-acid, but such an acid might readily be a result of the breaking down of the cellular elements of the gland, since many amino-acids are derivatives of protein destruction. The granular secretion would appear to be formed directly in the cytoplasm of the gland-cells during their most active period of swelling and breaking down. The chromaffin organs of the body (adrenal, medulla, etc.) do not appear to influence or be influenced by the presence of the cutaneous depôts of adrenalin.

As regards Living Matter.*—B. Vérigo discusses the difficulties in the way of forming clear conceptions of living matter. Physiologists find no essential difference between frog's muscle and horse's muscle; but grafting experiments point to marked specificity in the living matter of different types. On the one hand, there is the fact of division of labour among the differentiated cells of the body; on the other hand, many experiments show that underlying the differentiation in one organism there is a great similarity in essential features and capacities. Physiologists speak of the instability of living matter, which is continually undergoing metabolism; biologists studying heredity are wont to emphasize the stability of living matter. Biologists are dealing mainly with idioplasm, living matter of the first order, active during development, giving place to differentiated cytoplasm, but conserved in the nucleus and in a small quantity of cytoplasm around the nucleus. Physiologists are dealing mainly with living matter of the second order, differentiated cytoplasm.

* C.R. Soc. Biol. Paris, lxxix. (1916) pp. 1155-6.

Effect of Light on Rod-visual Cells of Frog.*—L. B. Arcy exposed *Rana pipiens* to bright diffuse light for eight hours, and to total darkness for twenty-eight hours. The myoid of the red rod-visual cell elongates in light and shortens in darkness. The mean length of 1000 myoids from twenty-three light-adapted eyes was $11 \cdot 6\ \mu$; that of 1000 myoids from twenty-three darkness-adapted eyes was $5 \cdot 9\ \mu$. The myoids of the green rod-visual cells are considered to show the same changes, but in a less degree.

Melanophores of Fundulus.†—R. A. Spaeth finds that the melanophores of this killifish respond to electrical stimulation after the fashion of smooth muscle, and are to be regarded as transformed smooth muscle-cells.

c. General.

Colour Mutations in Mice.‡—F. B. Sumner reports on the occurrence of some rather striking "sports," which seem to behave as discontinuous hereditary variations. Thus partial albinism occurred in hybrids between the sub-species *Peromyscus maniculatus sonoriensis* and *P. maniculatus rubidus*. Peculiar "yellows" appeared in a race of *P. maniculatus gambeli*. Various peculiarities in marking are also noted.

Poison-glands of Snakes.§—Marie Phisalix finds that the poison-gland so strongly developed in proteroglyphous Colubridæ and in Viperidæ has its homologue in the parotid gland of opisthoglyphous and aglyphous Colubridæ. This parotid gland was found in seventy-two opisthoglyphous and aglyphous species out of ninety-five examined; so that it must be called frequent rather than constant. Further examination showed the occurrence of a parotid in various representatives of Boidæ and related families (Ilysiidæ, Uropeltidæ, Xenopeltidæ, Amblycephalidæ). The relation of the gland to the dentition was also studied. There are species without parotids which have, nevertheless, fangs (*Prosymna*, *Pseudaspis*, etc.); there are species with parotids but without fangs (*Coronella*, *Contia*, *Xenopeltis*); some members of a genus may have a parotid while others have not (*Coluber*, *Polyodontophis*, *Rhadinea*, *Leptognathus*, etc.) The presence or absence of a parotid gland is independent of the dentition in snakes derived from Boidæ. Further experiments are required to show whether the parotid is to be regarded as essentially and primarily venomous, or whether it is primarily a salivary gland which has secondarily taken on a venomous function.

Ornamentation in Killifishes.‖—Henry W. Fowler discusses some features of ornamentation in killifishes, or toothed minnows (Fundulinæ). During the spawning season there are in some species minute spinules

* Journ. Comp. Neurol., xxvi. (1916) pp. 429-42. See Physiol. Abstracts, i. (1916) No. 8, p. 350.
† Amer. Journ. Physiol., xli. (1916) pp. 577-602.
‡ Genetics, ii. (1917) pp. 291-300.
§ Comptes Rendus, clxiv. (1917) pp. 959-62.
‖ Amer. Nat., l. (1916) pp. 743-50 (10 figs.).

adorning the scales and fin-rays. They also occur in Cyprinodontidæ and Anablepinæ. Each spinule is found to arise on or close to the edge of the scale, and not on its exposed surface, like the more distinct straight conic tubercles of Cyprinoids. The spinules are not always perfectly straight and rigid, but may be flexible or delicate. Those on the anal fin-rays are generally curved slightly, and are also often close together, though not perfectly regular. They probably disappear after spawning. Their arrangement or design differs characteristically in different species.

The Individual in the Animal Kingdom.*—H. V. Wilson maintains that in biology individuals concern the inquirer only in so far as they are lumps of specific substances, of species-plasms. The formal or morphological conception of the animal individual varies with the group. An amœba is an individual of the first order, an earthworm of the second order, a "Portuguese Man-of-War" of the third order. Regeneration experiments show that we cannot say of the individual, "He is there, and not there," for, being "there," with a stroke of the knife we can make two out of one. Phenomena of reduction or involution in sponges, which the author has especially studied, show that the individual body may as a whole die, but remain alive in spots, the flesh here passing into a condition of unspecialized regenerative tissue (technically "totipotent"). Individuality is abandoned; the constant exchange of stimuli between the various parts of the body is interrupted; areas sink for the time being, at least, into a low level of non-specialization. Particles of fragmented sponges and hydroids may combine to form the starting-point of a new creature. The uniqueness of the individual must be very secondary in such cases; the species-substance is the primary and fundamental thing. This is borne out by the phenomena of fusion and grafting. The individual character of the organism is not radically different from that of inorganic bodies. Similarly, embryos may be subdivided into two or several variable embryos; two or several may be fused; components of two individuals may be combined. The animal body is "only the expression of the active forces of a specific substance, a specific protoplasm. Its uniqueness in the higher forms is deceptive. The concept that an organism is primarily made up of a specific plasm, and the germ-cells are only small lumps of the plasm, provides in itself a sufficient working basis for many classes of investigations." The author does not discuss its applicability in the study of animal behaviour, where the reality of an individual agent seems in many cases clear.

Rôle of Selection in Evolution.†—W. E. Castle recently delivered an important lecture estimating the rôle of selection in the light of recent advances. A period of doubt was inaugurated about 1900 by De Vries' Mutation Theory and by Johannsen's Pure Line Theory, and many biologists regard selection as an obsolete agency. But even if

* Journ. Elisha Mitchell Sci. Soc., xxxii. (1916) No. 4, pp. 1–18.
† Journ. Washington Acad. Sci., vii. (1917) pp. 369–87.

mutation produces all new and heritable variations, the persistence of these depends on selection.

Darwin assigned to the selection of fluctuations (quantitative, plus or minus variations) a major part in evolution ; De Vries assigned to it a minor part ; and Johannsen no part at all. As regards sports or discontinuous variations, Darwin assigned to their selection a minor part in evolution (chiefly among cultivated plants and domestic animals) ; De Vries ascribed to a particular kind of sports (his "mutations") a major part in evolution ; and Johannsen ascribes an exclusive part to a type of variation which would include both Darwin's sports and De Vries' mutations. Johannsen classifies variations into those which are inherited (genotypic) and those which are not inherited (phenotypic), but they cannot be securely distinguished except by experiment.

[The recorder would put in a plea for the usage which distinguishes exogenous somatic *modifications* from endogenous germinal *variations*, the latter then admitting of further classification.]

The discovery of Mendelian unit-characters introduces a new uncertainty. Are these fluctuations or sports ? Do they arise solely by mutation, or also by the cumulation of fluctuations ? De Vries showed that certain mutations were associated with chromosome changes and involve Mendelian unit-characters. Morgan has shown that in *Drosophila* a unit-character change almost certainly involves a change in a definitely localized part of a single chromosome. He regards unit-character variations as the only kind of genotypic variations, and these as fluctuating (if at all) only through the interaction of other unit-characters, each one by itself being incapable of fluctuation.

According to Darwin.	*According to De Vries.*
1. New types are for the most part created gradually.	1. New types are created only abruptly.
2. New types are for the most part plastic.	2. New types are fully stable.
3. One evolutionary change follows upon and is made possible by another.	3. One evolutionary change has no necessary relation to another.
4. Natural selection determines what classes of variations shall survive, and, in consequence, what shall be the variable material subjected to selection in the next generation.	4. Natural selection determines only what classes of variations shall survive, and exercises no influence on the subsequent variability of the race.
5. The further evolution of our domestic animals and cultivated plants (and of man himself) is to some extent controllable, because we can by selection influence the variability of later generations.	5. Evolution is beyond our control, except as we discover and isolate variations.

The evidence from palæontology, geographical distribution, and classification points to a gradual progressive process rather than to abrupt mutation. The evidence from experimental breeding points both ways.

The principal tools of the breeder are hybridization and selection. Hybridization favours the occurrence of variations, but Lotsy is extreme in regarding all genetic variability as the result of hybridization. This is flatly disproved by observations of Johannsen, who reports the occurrence of mutations in genotypically pure lines of beans, as also by the remarkable series of variations observed by Morgan in an inbred race of the fruit-fly.

As regards selection, the mutationists hold that it can do nothing but isolate variations; the selectionists hold that selection can accomplish more than the mere isolation of variations, inasmuch as it can, by a series of selections, influence further variability. According to Castle, the facts warrant adherence to the selectionist position.

De Vries was the first to show the limitations of persistent selection. But more conclusive were Johannsen's experiments with pure lines of beans, which proved that selection continued generation after generation in a particular line may be without result, so far, for instance, as average seed size is concerned. Castle considers carefully the attempts that have been made to generalize Johannsen's brilliant demonstration of the principle of pure lines. In many cases mutations do occur in pure lines, in defiance of the definition, and thus material for selection is afforded; but it seems clear that a race may become a *ne plus ultra* "pure line" as regards certain characters. Thus, in the case of certain characters in guinea-pigs, Castle has repeatedly attempted without success to bring about a change by selecting within an inbred race. "Thus a very dark form of Himalayan albino, after a certain amount of improvement by selection, could not be further darkened to any appreciable extent."

On the other hand, certain characters of guinea-pigs, rabbits, and rats have been found to respond readily to selection in a particular direction. Castle's experiment with hooded rats "selected simultaneously in plus and minus directions has produced one race which is black all over except a white patch of variable size underneath, and another race which is white all over except for the top of the head and the back of the neck, which are black. The races do not overlap at all, and have not done so for many generations, though they still continue to diverge from each other as the result of continued selection." In similar experiments with Dutch marked rabbits it has been found possible by selection to increase or decrease the amount of white at will. The principle of the pure line manifestly does not apply to these cases.

Castle's criticism of the attempts to generalize Johannsen's principle of pure lines may be illustrated 1. It remains to be proved that a line of beans is as devoid of genetic variation in other particulars as it is in seed size. 2. It remains to be proved that all self-fertilizing organisms fall automatically into pure lines. 3. The pure-line principle does not apply without exception to asexually reproducing organisms. 4. Attempts to extend the pure-line principle to organisms which are not self-fertilizing have met with small success.

It seems to come to this, that divergent conclusions are in part due to the data utilized. "A study of albinism alone would lead one to believe in the fixity and constancy of Mendelian genes, and the impossibility of modifying them by selection. A study of white-spotting leaves one with the unshakable conviction that this form of gene is plastic and yields readily to selection. Where only genes of the former sort are involved, the principle of the pure line is applicable; where genes of the latter sort are involved, it is not applicable."

Castle inclines to the view that in the smaller mammals, which he has particularly studied, very few characters can be safely referred to the agency of perfectly stable genes. Very important is his conclusion that, "aside from colour, there are very few valued economic characters in our domestic animals which are not inherited after the manner of blends."

In conclusion, Castle points out that, "in the case of such characters as white-spotting in mammals, it is evident that a change in the mean of the character in a particular direction in consequence of selection actually displaces in the direction of selection the centre of gravity of variation, so that in a very true sense selection makes possible further variation in that particular direction." The same is probably true as regards protein-content and oil-content in the Illinois University Indian corn experiment.

At the same time, it will be recognized that selection, whether natural or artificial, is, as the mutation theory rightly holds, primarily an agency for the elimination of variations, not for their production. It can only act on variations actually existing; it cannot initiate new lines of variation; but it can continue and extend variation already initiated by shifting in the direction of selection the centre of gravity of variation. It is limited to effecting change in existing types of organisms; it helps them along lines in which they show a tendency spontaneously to vary.

Fundamental Biological Law.*—H. F. Osborn suggests the following as "the most fundamental biologic law which can be expressed from our existing knowledge":—"In each organism the phenomena of life represent the action, reaction, and interaction of four complexes of physico-chemical energy, namely, those of (1) the inorganic environment, (2) the developing individual (cytoplasm and somatic chromatin), (3) the germinal or hereditary chromatin, and (4) the organic environment. Upon the resultant actions, reactions, and interactions of each organism selection is constantly operating whenever there is competition with corresponding actions, reactions, and interactions in other organisms."

Toxicity of Serum of Muræna helena.†—W. Kopaczewski has made experiments showing the extreme toxicity of the serum of this eel. The results of sub-cutaneous and intra-peritoneal injections of guinea-pigs, rabbits, and dogs showed very rapid action. A single dose was some-

* Proc. Nat. Acad. Sci., U.S.A., iii. (1917) pp. 7 9.
† Comptes Rendus, clxi. (1917) pp. 963–4.

times enough to cause instantaneous death. The rapidity of the poisoning and the post-mortem appearances recalled anaphylactic shock.

The Selection Problem.*—Raymond Pearl presses the question whether selection does actually produce evolutionary change. There are a few experiments (from Weldon to Harris) which agree in indicating that the survivors are physically different from the eliminated. Nearly as many investigations have shown an elimination which is not discriminative. Moreover, it is necessary to have proof that the somatic differences on which selection works are heritable. Pearl illustrates this by referring to his recent experiments on the variation called "side-sprig" in the comb of poultry, which gave no proof of the heritability of the character. Furthermore, survival often depends on somatic *modifications*. It appears that selection experiments with agents that directly affect the germ-cells (e.g. alcohol on poultry) will yield valuable results.

"We find the literature of evolution cluttered with a lot of utterly preposterous statements about domestic animals and plants, masquerading as valid evidence for the selection doctrine." Thus, "the principle of the gradual accumulation by continued selection of minute somatic variations has had no essential part in the origin or amelioration of certainly a great many of the best varieties of agricultural plants which we have to-day." For some animal breeds the same is true; thus the history of bantams "shows very clearly that Darwinian selection plays an extremely minor and unimportant part." Large breeds of poultry (e.g. Wyandottes and Orpingtons) may originate from hybridization, followed by close inbreeding of desired segregating types. In other cases (e.g. White Plymouth Rock and White Cornish) sudden mutations by loss of factors have afforded the starting point.

Controlled *ad hoc* experimentation on selection has yielded opposite results according as to whether the hereditary factors for the character which formed the basis of the selection were or were not positively known to be in a homozygous condition in all the individuals of the race experimented with. In "pure line" conditions the results of the continued selection have been on the whole negative. Notable exceptions occur, however, as in Jennings' work on *Difflugia*, especially in the case where the feature selected was the ability to produce offspring with a particular character. The hopeful line of selection is a selection of individuals which are demonstrably able to produce a particular kind of gamete. "In ordinary Darwinian selection we select the kind of somata we want, and trust blindly that a wise providence has implanted in them the sort of gametes we need to get further somata like those we selected." But the result is often disappointment.

In many experiments with sexually reproducing organisms, selection has been attended with an alteration of the type in the direction of the selection. Of such cases there are two rival interpretations—demanding further experiment. "On the one hand, it is held, because there has been an alteration of type in point of time coincident with successive

* Amer. Nat., li. (1917) pp. 65-91.

selections, that selection on the basis of personal *somatic* qualities only, as such, in and of itself, has altered hereditary factors in the germ-plasm. This view makes selection a cause of genetic variation, a total reversal of the position held by Darwin and most of his followers. The opposing view is that selection can only be successful in altering the type when heredity determiners to produce the desired somatic qualities are already present in the germ-plasm. Selection, on this view, has nothing whatever to do with the causation of the variation, and is wholly powerless and without effect on the race, unless either (*a*) the basis of the selection is directly gametic, by means of progeny performance test, or (*b*) the somatically selected individuals happen by good fortune to carry the necessary hereditary determiners in their germ-plasm."

Digital Malformation.*—A. Clerc and Bobrie describe in an Arab tirailleur—without any pathological feature, or trace of rachitism, or of glandular insufficiency—an interesting malformation of the digits as revealed by radiographs. The fingers were very unequal. The second phalanx of the little finger was a small cubical body ; the second phalanx of the second finger was divided into two ; the first finger of the left hand showed in its second phalanx the separation of a small rounded bone from the main portion. In the toes the second phalanx was absent on the little toe, reduced to a small body on the fourth and third. On the second toe the second phalanx was formed of two pieces side by side, producing a somewhat bifid appearance. The two feet were symmetrical with one another, which was not quite true of the hands. There may have been some partial ossification of phalanges and subsequent separation of bony parts, which were united by cartilaginous bridges.

Changes in Skin with Age.†—Ed. Retterer finds that in youth and adult life the dermis is renewed at the expense of epithelial cells of the epidermis. In advanced age the epithelial cells proliferate less or not at all. The epidermis becomes more delicate ; it no longer gives over any cellular element to the dermis ; it contributes to the atrophy of the dermis. The diminished vitality of the epidermic cell is the cause of the atrophic or senile condition of the skin. Thus Retterer confirms his previous conclusion that the epithelium contains a reserve of living matter, and may be regarded as a persistently formative tissue.

INVERTEBRATA.

Mollusca.

New England Molluscs.‡—Charles W. Johnson has made a faunal list of New Zealand molluscs, which contain 738 species and 71 varieties.

* C.R. Soc. Biol. Paris, lxxx. (1917) pp. 123–6 (4 figs.).
† C.R. Soc. Biol. Paris., lxxix. (1916) p. 1113–8.
‡ Occasional Papers Boston Soc. Nat. Hist., vii. No. 13 (1915, received 1917) pp. 1–231.

γ. Gastropoda.

Migration of Retinal Pigment in Planorbis.*—L. B. Arcy finds that light causes the pigment to migrate distally (towards light) in about five hours; darkness causes proximal migration in five hours. Light produces the same effect on excised eyes as on eyes *in situ*. Warmth (30° C.) has the same effect as light; cold (3° C.) the same effect as darkness.

Structure of an Eolid.†—Harold Heath describes *Chioræra dalli* sp. n., a littoral Eolid from British Columbia. The various systems of organs are surrounded by a loose meshwork of connective-tissue and muscle-fibres, with the intercommunicating spaces serving as blood sinuses. An account is given of the alimentary system (without trace of jaws, radula, or distinct salivary glands; with a digestive gland generally distributed throughout the body); the vascular system, which is mainly lacunar, the aorta disappearing soon after it leaves the heart; the kidney, with a long thin-walled reservoir; the reproductive system; and the nervous system.

Varieties of Dog-whelk.‡—Harold S. Colton has made an ecological study of *Thais* (*Purpura*) *lapillus* in the neighbourhood of Mount Desert Island, Maine. Over 12,000 whelks were collected from sixty-seven localities, sorted, and the variations tabulated. These tables were then compared with the environment of the whelks.

The whelks are limited in number by the following factors:—1. Cannibalism within the egg-capsule, only ten to twelve hatching out of 300 to 400 eggs. 2. The available cracks in the rocks with sufficient food. 3. The predatory attacks of fishes, such as pollacks. 4. The use of half-grown whelks by herring-gulls, which regurgitate the shells. 5. The destruction of large specimens by gulls, which drop them on flat rocks (as is also done with *Buccinum* and *Strongylocentrotus*). 6. The attacks of a parasitic sporocyst. 7. Accidents due to movements of rocks by the surf. 8. Destruction by ice.

Among the adaptations may be noted the strong shell, the strong adhesive foot, the habit of sheltering under rocks and *Fucus*, and the method of egg-laying. There are many colour varieties—white (with intense and dilute chestnut), chestnut, purple, pure yellow, striped, etc.

The colour varieties seem to be hereditary, and probably unit characters. The formation of lamellæ, as in var. *imbricata*, is not due to environmental action. Though the surf environment is the antithesis of the harbour environment, the effects on the whelks are in some respects similar, thus the growth is slower than in the optimum bay environment, where no mud gathers; there is a tendency to dark colour and to lamellation.

Natural selection has some determining action on the colour varieties present. The colour of the rocks, whether light or dark, has an effect.

* Journ. Comp. Neurology, xxvi. (1916), pp. 359–90. See Physiol. Abstracts, i. (1916) No. 8, p. 349.
† Proc. Acad. Nat. Sci. Philadelphia, lxix. (1917) pp. 137–48 (3 pls.).
‡ Proc. Acad. Nat. Sci. Philadelphia, lxviii. (1917) pp. 440–54 (4 figs.).

White barnacle-covered rocks have more white whelks than have mussel-beds a few feet away. Those living on rocks near mud-flats are darker than those on the more exposed parts of the same islands. Where the struggle for existence is greatest on the exposed islands and the muddy harbours, selection tends to preserve the dark-coloured and the lamellated.

Nervous System of Crepidula and its Development.* — Harold Heath has examined the nervous system in *Crepidula adunca* and *C. nivea*, and studied its development in the former species. The central nervous system in *C. adunca* is situated in the base of the neck, in a spongy mass of connective tissue, placed between the pedal musculature and the overlying mantle cavity. It conforms to the highly-centralized type characteristic of the Monotocardia generally, with cerebral, pleural, and pedal ganglia closely appressed. A description is given of the buccals (slightly attached to the dorsal surface of the radula musculature), the elements of the visceral loop (sub-intestinal, supra-intestinal, and visceral), and the osphradial ganglion situated far forward on the left side of the mantle cavity.

Shortly after the first appearance of the foot, the ectodermic cells immediately in front of the lateral angles of the mouth-opening commence to elongate, and each area forms a well-defined, probably sensory, ridge and the tentacle. A migration therefrom forms the cerebral ganglia. Synchronous with this, cells migrate inwards from the foot and form the pedal ganglia. Sections give no indication of cell-division after the cells have left the ectodermic layer. The same is true of the other ganglia.

The buccal ganglia are the only ganglia which do not directly arise from cells migrating from the overlying ectoderm. They seem to be products of the cerebral ganglia. The origin of pleurals and viscerals is described.

Scottish Nudibranchs.†—W. Evans and W. E. Evans contribute some notes on Nudibranchs from the Firth of Forth. An addition to the local list is the minute *Hermæa dendritica*, which feeds on *Bryopsis* and seems to pass through two generations in the year. Another minute form (9–10 mm.) is *Lamellidoris aspera*, which might be readily passed over as a young stage of one of the larger Dorids. Interesting also is the minute Planarian-like *Limapontia nigra*.

Arthropoda.

α. Insecta.

Relation between Gonads and Secondary Sex Characters in Insects.‡—E. A. Cockayne discusses the possibility of there being in insects a relation between the gonads and secondary sex characters, such as is found in Vertebrates. Experiments in castration and transplanta-

* Proc. Acad. Nat. Sci. Philadelphia, lxviii. (1917) pp. 479–85 (2 figs.).
† Scottish Nat., No. 65 (1917) pp. 105–10.
‡ Trans. Entomol. Soc. London, 1916, parts iii.–iv. (publ. 1917) pp. 336–42.

tion are against it. The study of halved gynandromorphs and intersexes is against the idea that the secondary sex characters are in any way dependent on the gonads or on any portion of the internal sexual apparatus. There seems little likelihood of there being some gland of internal secretion independent of the sexual organs.

It may be that the tissues are sexually differentiated from the first in insects and require no secretory stimulus, but stylopization and temperature experiments show that the secondary sex characters can be changed at a late stage. It may be that there is in all animals a sexual formative substance which in some cases requires the co-operation of internal secretions if the sex characters are to be perfected, and in some cases does not. But on this view, unless the inferences from gynandromorphism are incorrect, the sexual formative substance must be produced in various parts of the body, if not by all the tissues.

Digestion in Insects.*—Eldon W. Sanford confirms the observation of Petrunkevitch that fat is digested and absorbed in the crop of the cockroach. A. Krause † finds that in some carnivorous insects some digestion takes place in the crop and gizzard.

Habits of Larva of Lycæna arion.‡—T. A. Chapman discusses the inter-relations between ants and the larvæ of Lycænines. The initial point would probably be found in the case of those "blues" whose larvæ are collected by the ants and placed on food-plants actually on the ants' nest, as occurs with *argyrognomon*, *coridon*, and *bellargus*, and probably other species. Perhaps the nest is extended towards a suitable plant.

"It might be said that the ants do take these larvæ to their nests, as they leave them, when at rest, on the rootstocks of their food-plants, and cover them with loose material; and I have seen ants remove a small larva that they appeared to think was in danger when I disturbed them. A slightly deeper enclosure in the nest, and a cannibal proclivity on the part of the larva, would initiate the *arion* habit."

The normal number of moults in Lycænines is four, and the normal instar for hibernation (of those that hibernate as larvæ) is the third. It is probable that *arion* was at first carried into the nest in the third instar, and there hibernated harmlessly.

Some carried in might take another moult before hibernating and begin eating the larvæ of the ant. A tendency to vary towards diminished size would also be involved in the causes leading to hibernation in the fourth instar. Those that survived the animal diet and the dangers from ants would benefit by the protection during the winter and the assured dietary. But the most remarkable fact as regards the hibernation of *L. arion* is that it does so as a half-grown larva in the last instar. No other Lycænid is known to do so. This change of

* Proc. Soc. Exper. Biol. Med., xiii. (1916) p. 193. See Physiol. Abstracts, i. (1916) No. 8, p. 360.

† Zeitschr. Allg. Physiol., xvii. (1916) pp. 164–7. See Physiol. Abstracts, i. (1916) No. 8, p. 360.

‡ Trans. Entomol. Soc. London, 1916, parts iii.-iv. (publ. 1917) pp. 315–21.

habit must have developed after the use of the ants as hosts was established.

Structure and Systematic Position of Micropteryx.*—T. A. Chapman points out that while the female genitalia of Lepidoptera have two openings—a terminal one for oviposition and one in the eighth segment for pairing, there being only nine segments in the abdomen to be counted, the genus *Micropteryx* has ten segments and no genital opening except in the tenth segment. "This fact by itself seems to be sufficient to prevent *Micropteryx* being classified as belonging to the Lepidoptera, even in a sub-order." The new order Zeugloptera is proposed. A very copious illustration is given of the external structure of the abdomen, heads, and larval stages of *Micropteryx*.

Gynandromorphous Lepidoptera.†—E. A. Cockayne continues his study of these forms, dealing with two cases of *Amorpha populi* and one of *A. hybridus* (*A. ocellatus* male × *A. populi* female). The first *A. populi* showed in all external characters perfect halving. On dissection it showed a testis, vesicula seminalis, vas deferens, glandula accessoria, ductus ejaculatorius, and penis to the right, and an ovary with four follicles, oviduct, spermatheca, cement-gland, and bursa copulatrix to the left. It was, in fact, a true genetic hermaphrodite without any reduplication of organs, and with only one defect, absence of the ductus bursæ or seminis. Full details are given.

The second gynandromorphous *A. populi* was not perfectly halved, but was predominantly female to the right, predominantly male to the left. There was only one gonad, an ovary with four follicles, which lay on the right. It had an oviduct, cement-glands, spermatheca, very small bursa copulatrix and caput bursæ, but no ductus seminis. On the male side there was only a penis with a soft saccular mass of chitin representing the blindly ending ductus ejaculatorius. The external genitalia showed a completely halved arrangement.

The hybrid was perfectly halved, male on the right, female on the left. The secondary sex characters of both sexes were perfectly developed, but the insect had neither ovary nor testis. The external genitalia were perfectly halved.

In these three cases the author finds further proof that the same underlying cause can produce true lateral genetic hermaphrodites, halved or lateral gynandromorphs with one or more gonads of one sex only, or without gonads of either sex, but with external structures of both sexes (primary somatic hermaphrodites). The differences appear to be due to a failure of part of the genital tract to develop, a failure which is specially liable to affect the gonad itself. The author discusses the theory of gynandromorphism. Independently of T. H. Morgan, he has advanced the view that at some early stage in division a sex-chromosome fails to pass from one pole and becomes lost.

* Trans. Entomol. Soc. London, 1916, parts iii.–iv. (publ. 1917) pp. 310–14 (12 pls.).

† Trans. Entomol. Soc. London, 1916, parts iii.–iv. (publ. 1917) pp. 322–35 12 pls.).

Influence of Coloured Light on Butterflies.*—J. Pereiraz and Koehler have experimented with caterpillars of the small tortoiseshell butterfly, which were placed in black, violet, blue, orange, and red surroundings. Those in a violet box showed great mortality; only a few reached the pupa stage. In the blue box there was also considerable mortality, but not so much. In the orange and red boxes there was little disturbance.

Violet light, when not fatal, accelerates the metamorphosis. Blue light comes next. Those subjected to red and orange rays are smaller than those which have lived under blue or violet. The violet environment appears to induce more vivid coloration.

South African Bagworms.†—Ernest Warren explains that "bagworms" do not form a natural group of insects; they belong to several families of moths; the name refers to the habit the larvæ have of forming a case or bag in which they live during their active life and pupation. Certain marked resemblances in structure and instinct are observed, and investigation is necessary to determine whether these are due to phylogenetic relationship or are examples of convergence arising through like needs imposed by similar environment. Some of the bagworms, like that which attacks the exotic Black Wattle, are very important economically.

A. J. T. Janse ‡ deals with bagworms included in the families Psychidæ and Cossidæ, and describes two new species of *Acanthopsyche*, one of *Psyche*, one of *Gymnelema*, and one of *Trichocossus*. The larvæ of Psychidæ live in their little dwellings from the time they emerge from the egg until they are mature; the females, which are wingless, remain in the bag, and may even deposit their eggs therein. Most lepidopterists rank Psychidæ near Cossidæ, and there must also be a close relationship with certain groups of Tineidæ. Janse removes *Epichnopteryx* and *Fumea* from the Psychidæ, because in both genera the hind-legs have well-developed middle spurs, which are absent, or at the most very rudimentary, in all true Psychidæ.

E. Meyrick § describes some new Tineid bagworms, *Fumea obscurata* sp. n., and four new species of *Melasina*; also among the Adelidæ, *Ceromitia xanthocoma* sp. n.

C. C. Hardenberg ‖ gives a general sketch of the life-history of bagworms. The first care of the larva is to make its home of small pieces of leaf and the like, woven together with silk, or sometimes glued. The cases are protective, and often extraordinarily like the surroundings. The young larvæ are dull grey to dark brown, with a relatively strong thorax, and a dorsally flexed abdomen. The inside of the bag is kept very clean. Excessive moisture is rapidly fatal, inducing a bacterial disease. When the time for pupation approaches, the larva seeks a safe

* Ann. Sci. Phys. Nat., xliii. (1917) p. 339. See Rev. Gén. Sci., xxviii. (1917) p. 358.
† Ann. Natal Museum, iii. (1917) pp. 587–8.
‡ Ann. Natal Museum, iii. (1917) pp. 589–614 (1 pl.).
§ Ann. Natal Museum, iii. (1917) pp. 615–8.
‖ Ann. Natal Museum, iii. (1917) pp. 619–86 (3 pls. and 6 figs.).

place, and the bag is strengthened to keep out spiders and ants. A true cocoon is sometimes made inside the case. The numerous eggs are laid in or on the bag, or quite away from it. No evidence of parthenogenesis, such as occurs in some European bagworms, was found. The systematic classification of bagworms is then discussed.

Hardenberg then passes to consider in particular the Wattle Bagworm, *Acanthopsyche junodi*, which was some fifteen years ago an "entomological curiosity," and has now evolved into a pest of prime economic importance, seriously menacing the Black Wattle (*Acacia mollissima*) industry in Natal.

A description is given of the eggs, which are laid in a mass inside the pupa-case of the female, and take 60–65 days to incubate; and of the six instars of the larvæ. The distribution of the species falls on the young caterpillar, not on the parent moth; hence three special instincts, in contrast to most caterpillars:—(1) a decided positive phototropism; (2) an extensive use of the spinning glands to make a descending line, a web on the branches, and threads for the bag; and (3) a meandering habit. Dispersal is helped by the wind, the silken thread serving as a parachute to the exposed caterpillars, though they are sometimes carried up within the bag. The caterpillars also get entangled on birds and rarely on a mammal. The making of the bag is discussed at length, also the occurrence of parasites and of fungoid and other diseases which check the multiplication of bagworms. The author then passes to the making of the extra inner lining of the bag and to the subsequent making of the cocoon. He describes the pupæ, the winged males active in the sunlight, the females which do not leave the chrysalis case, the fertilization-process, and so on. The fertility ranges from 438 to 3098 eggs, with 1756 as a mean average.

Structure of Agaoninæ.*—G. Grandi describes from Erytræa both sexes of three Chalcidids (Agaoninæ), viz. *Blastophaga allotriozoonoides* Grnd., *Ceratosolen arabicus* Mayr, and *Sycophaga sycomori* (L.), and from Uganda the females of *Ceratosolen megacephalus* Grandi, and *Sycophaga silvestrii* Grnd. *tenebrosa* Grandi. Careful figures are given of the head, antennæ, mouth-parts, and limbs.

Parthenogenesis among Worker Bees.†—Rupert W. Jack reports on some interesting experiments made by G. W. Onions on the Cape honey bee. It exhibits a divergence from the European varieties, inasmuch as a far greater proportion of the workers are apt to develop the habit of laying eggs, which may produce workers, queens, or drones, but do mainly produce workers.

In the Cape worker bee, probably belonging to the race *unicolor* var. *intermissa* Latr., the spermatheca is not vestigial as in the typical worker bee, but is a nearly spherical body, 0·54 mm. by 0·45 mm. But the

* Bull. Soc. Entomol. Ital., xlviii. (1917) pp. 1–42 (12 figs.).

† Trans. Entomol. Soc. London, 1916, Nos. iii.–iv. (publ. 1917) pp. 396–403 (2 pls.).

laying workers showed no trace of spermatozoa, and the possibility of insemination must be discarded.

A hive with a strong nucleus of bees was twice thoroughly inspected by Jack and found to be queenless; there was systematic egg-laying on the part of the workers. In many cases several eggs were laid in a cell. The eggs developed into workers, even when the eggs had been laid in drone cells. Later on drones developed from capped cells. From another queenless hive numerous workers and several queens were reared. The possibility of the eggs having been brought in from outside was excluded. The experiments detailed seem straightforward and careful, and it looks as if Onions had proved his case: that the eggs of laying workers of the Cape variety of the honey bee produce mainly workers, and that they develop into queens as readily as the fertilized eggs of queen-bees.

Sex in Bees.*—Bourgeois criticizes the theory of Dzierzon that the queen lays facultatively fertilized eggs and unfertilized eggs, the former developing into queens or workers, the latter into drones. He maintains, somewhat vaguely, that the theory is not in harmony with the experience of bee-keepers, and that it is improbable on general grounds that the queen-bee should have this power of sex-control.

A virgin queen lays eggs "with a single sexual particle"; a young queen normally inseminated lays eggs "with two sexual particles." The workers determine what will result from the development of the eggs.

Three sets of facts are submitted which lead Bourgeois to conclude that the control of sex rests with the young nursing bees. It is believed that they can operate upon a fertilized ovum which should normally develop into a female, and suppress one of the "sexual particles" so that the egg develops into a drone.

O. Morgenthaler † calls attention to the theory of F. Dickel that a normal inseminated queen lays only fertilized eggs, and that the workers determine the sex by a treatment with secretions. They treat eggs laid in drone-cells with a "male secretion," and eggs laid in worker-cells with a "female secretion." But there is no evidence of two kinds of drones—those developing from the eggs laid by a virgin queen, and those developing from fertilized ova which the workers have treated. Nor do the early stages in the development of drones show any trace of the presence of a spermatozoon.

The theory of Bourgeois is also that the inseminated queen lays only fertilized eggs, but that the workers are able to suppress one of the "sexual particles" in the egg. They are able to bring about a defecundation of the fertilized egg. This implies a unique phenomenon among insects, but it is supported also by Göldi, who suggests that the workers can block the micropyle of an egg, or can by a secretion kill the spermatozoon. Morgenthaler suggests that careful observation should be made as to the visit of a worker to a drone-cell after the queen has laid an egg there.

* Bull. Soc. Romande d'Apiculture, xiii. (1916) pp. 102–5.
† Bull. Soc. Romande d'Apiculture, xiv. (1917) pp. 35–9.

Oviposition and Larva of Rhynchites conicus.*—L. Bordas has studied this little beetle, the eggs of which are laid in small holes bored in the buds of fruit-trees. The female after laying the eggs makes a cut with her mandibles below the bud, so that the flow of sap is checked. The drying bud is eventually shaken off by the wind. The egg hatches in 8–15 days according to the weather. The larva is a white footless grub with very strong mandibles and minute two-jointed tubercle-like antennæ. There are two filiform mandibular glands opening at the base of the mandibles, and aiding in the excavation of a larval gallery. The gut is like that of other Curculionidæ, e.g. *Anthonomus*; it is two and a half times the length of the larva; it shows a short straight œsophagus with a posterior valve, a mid-gut with two distinct regions, and a sinuous hind-gut.

North American Coccinellid Larvæ.†—A. Bøving gives a synopsis of genera and a special account of the larva of *Hyperaspis binotata* Say, a primitive ladybird type. In this form the mouth cavity is enlarged and is capable of holding an entire *Lecanium* larva, on which the creature chiefly feeds. The mandibles can only meet at their apices, and their bases work against a peculiar hypopharyngeal bridge. Thus they grind the juices out of their prey and the fleshy lips of the ventral mouth-parts keep them from losing any of it. While *Hyperaspis* represents the primitive type, the most highly developed larvæ are found in the Chilocorini. Nine groups are recognized and distinguished.

Air-sacs of Larva of Corethra plumicornis.‡—K. S. Bardenpleth and R. Ege demonstrate a correlation between the structure of the air-sac wall, the power of air-sacs to withstand pressure, and the depths at which the larva is normally living. The air-sacs of larvæ living at considerable depths (30–40 m.) are a much more perfect hydrostatic apparatus than those of larvæ from ponds.

British Lice and their Hosts.§—Percy H. Grimshaw has compiled a useful list of British Anoplura, with their hosts. A diagnostic key of the genera, adapted from that of Ferris, is supplied. Twenty-five species are recorded.

δ. Arachnida.

New South African Spiders.‖—John Hewitt gives careful descriptions of a number of new species—*Hemiblossia idioceras*, *Leptherens rattrayi*, two of *Stasimopus*, and *Amaurobioides africanus*. The last was found on the seaward face of rocks near East London. "Their retreats, made of tough silk, lodged in pits and crevices of the rock surface, were

* Comptes Rendus, clxv. (1917) pp. 70–3.

† Proc. U.S. Nat. Museum, li. (1917) pp. 621–50 (4 pls.).

‡ Vidsk. Medd. Dansk. Nat. Forening, lxvii. (1916) pp. 25–42. See Physio Abstracts, i. (1916) No. 8, p. 358.

§ Scottish Nat., No. 61 (1917) pp. 13–17; No. 63 (1917) pp. 65–8.

‖ Ann. Natal Museum, iii. (1917), pp. 687–711 (1 pl. and 4 figs.).

situated near to or just below the average high-water mark, where they were liable to complete submergence at spring tides." Rattray found that while many of the retreats were often merely drenched by spray, numerous small retreats occupied by immature specimens occurred amongst the wet seaweed exposed at low water, and must be submerged every high tide. Two other species have been previously recorded from sea-shore rocks—*A. maritima* O. P. Cambr., from Otago, and *O. piscator* Hogg, from the Campbell Islands. The African form is very near *A. piscator*. Perhaps the genus is widely distributed in the southern hemisphere; perhaps distribution is aided by wind, perhaps by floating seaweed.

Water-mites.*—William Williamson gives a useful account of the general characters of Hydracarina, and describes in detail *Thyas venustra*, a type of the Limnocharidæ, and *Limnesia fulgida*, a type of the Hygrobatidæ. The two families are contrasted, and a key is given to five Scottish species of *Limnesia*. A short account is given of the life-history of water-mites. The eggs are usually laid in anchoring and protective gelatinous masses. The hexapod larva that emerges seeks an aquatic insect, to which it attaches itself by its relatively strong palpi. It is very doubtful if the larva is really parasitic at all, as shortly after attachment the limbs drop off and the larval body begins to swell out owing to the development of the nymphal body within. When mature the skin is ruptured, and the eight-legged nymph emerges. The host is of necessity some insect which either inhabits or spends part of its existence near the surface of water. Consequently, during the transition from larva to nymph, the mite exists for considerable intervals—i.e. during the flight of insects—out of the water, and in this way in many cases the dispersal of species may be accounted for. Nymphs may readily be distinguished from adults by the presence of what has been termed a provisional genital area.

Occurrence of Pseudo-parasitic Mite on Cat.†—Stanley Hirst reports from a cat infected with mange the mite known as *Cheletiella parasitivorax* Mégnin, which normally lives in the fur of the rabbit and hare, and is said to feed on the minute Acari (*Listrophorus*, etc.) found on these rodents. Presumably in the case of the cat it fed on *Notœdrus cati*, which causes the mange. This species of *Cheletiella* can be readily distinguished from the others by the absence of the claws, which have entirely disappeared. A careful figure is given.

New Water-mites.‡—Chas. D. Soar describes *Dartia harrisi* g. et sp.n., from Dartmoor. The body is oval in outline, the skin soft, the eyes wide apart near the margin of the body; the legs without swimming-hairs, the fourth pair of legs without claws; the epimera in four groups; the genital area like that of *Libertia*, but with four acetabula (not the

* Scottish Nat., No. 62 (1917) pp. 37–47 (6 figs.).
† Ann. Mag. Nat. Hist., xx. (1917) pp. 132–3 (1 fig.).
‡ Journ. Quekett Micr. Club, xiii. (1917) pp. 1–6 (2 pls.).

usual three) on each side of the genital cleft; the palps with a long stiff bristle on the flexor edge of the second segment. The author also describes *Eylais wilsoni* sp. n., from near Staines. Each eye-capsule stands isolated on the skin without any connecting bridge, as in other species of the genus.

ε. Crustacea.

Nerve Fibres of Crustacea.*—J. Nageotte finds that all the nerve fibres in *Mysis*, *Palæmon*, and *Crangon* are medullated except those to blood-vessels and intestine. The fibres are ribbon-like in section. The myelin sheath is unbroken from beginning to end, but thinner at Ranvier's nodes.

Question of Species among Amphipods of the Genus Ampelisca.†—Chas. Chilton discusses with thoroughness the species of *Ampelisca*, and in particular the identity of *A. eschrichtii* Kröyer and *A. macrocephala* Liljeborg. These and some other species are to be referred to *A. eschrichtii* Kröyer, which is widely distributed both in Arctic and Antarctic seas, is most abundant and biggest in high latitudes, but also extends into low latitudes in both hemispheres, and in so doing may develop to sexual maturity while of smaller size. In these smaller specimens some of the characters are less marked, but no constant association of characters can be found warranting the establishment of distinct species. It is probable that this case is typical of that of many marine Amphipods.

Distribution of Amphipods.‡—Chas. Chilton discusses the distribution of *Elasmopus rapax* A. Costa and *Mæra inæquipes* (A. Costa). The former has been recorded as widely distributed—in the North Atlantic, Mediterranean, Indian Ocean. Chilton finds that it occurs also in Australian Seas, and Walker has recorded it from Rio de Janeiro and from Arica, Chile. Similarly, *Mæra inæquipes* occurs widely in Southern as well as in Northern Seas, having a distribution practically identical with that of *Elasmopus rapax*.

Sex Dimorphism in Hyale.§—Chas. Chilton finds that the male of a New Zealand Amphipod, *Hyale grenfelli* Chilton, is marked by the great dilatation and setose character of the terminal joints of the maxillipeds. The maxilliped in the female presents the ordinary characters common to allied species of *Hyale*, and its terminal joints show none of the numerous transverse rows of long fine setæ on the surface that are so characteristic of the male. There are also some slight sex differences in the gnathopods.

* C.R. Soc. Biol. Paris, lxxix. (1916) pp. 259-63. See Physiol. Abstracts, i. (1916) Nos. 5-6, p. 209.
† Journ. Zool. Research, ii. (1917) pp. 75-93 (7 figs.).
‡ Journ. Zool. Research, ii. (1917) pp. 17-19.
§ Ann. Mag. Nat. Hist., xix. (1917) pp. 273-6 (3 figs.).

Terrestrial Isopods of Natal.*—Walter E. Collinge describes six new species of *Cubaris* and two of *Philoscia*. The latter genus is heterogeneous and requires separating into definite genera based on sound structural characters. The mouth-parts of Isopods are by themselves very unsatisfactory for either generic or specific distinction, and this is particularly so in the genus *Philoscia*. "Apart from the question of variation, the abdominal appendages (pleopods) are scarcely less so, whilst any classification of the terrestrial Isopods founded upon sexual characters always leaves it open for the opposite sex to be described as a distinct species. I fully agree as to the great value of the antennæ and uropoda, and to these I would add the shape of the cephalon, the mesosomatic and metasomatic segments, and the telson."

Rare Woodlice in Scotland.†—Walter E. Collinge reports the occurrence of *Porcellio rathkii* and *Haplophthalmus danicus* from Dumbartonshire. The former is recorded for the first time from Scotland; the latter has been previously recorded from Ayrshire and Lanarkshire. In *P. ratkii* there is great variation in coloration and tuberculation, especially in the female. The beautiful little species *H. danicus* and its near relative *H. mengii* are apt to be confused with various species of *Trichoniscus*, but microscopical examination clearly shows that whereas in the members of the genus *Trichoniscus* the lateral portions of all of the metasomatic segments are clearly visible, in the genus *Haplophthalmus* only the 3rd, 4th, and 5th are seen, those of segments 1 and 2 being small and concealed beneath the pleural plate of the last segment of the mesosome. Of the 36 British species of terrestrial Isopods, 21 have been recorded in Scotland, 33 in England, 12 in Wales, and 25 in Ireland. Another rarity ‡ is *Ligidium hypnorum*.

Rare Scottish Woodlouse.§—William Evans reports from the Isle of May the occurrence of *Trichoniscoides sarsi* Patience. There is only one other Scottish record.

New British Terrestrial Isopod.‖—Walter E. Collinge describes *Trichoniscoides scabrous* sp. n., from Darwen, Lancashire. It is a small greyish-violet woodlouse, 5·9 mm. in length, readily distinguished by size and colour from *T. albidus* or *T. sarsi*, whilst in the form of the antennules, antennæ, mesosomatic and metasomatic appendages, uropoda and telson, there are well-marked distinctive features. Further, the body is much flatter than in either of the above-mentioned species and the pleural plates are more expanded.

Check-list of British Terrestrial Woodlice.¶—Walter E. Collinge has compiled a useful check-list showing the name and authority for each

* Ann. Natal Museum, iii. (1917) pp. 567–85 (3 pls.).
† Scottish Nat., No. 66 (1917) pp. 137–9.
‡ Scottish Nat., No. 64 (1917) pp. 94–5.
§ Scottish Nat., No. 62 (1917) pp. 35–6.
‖ Journ. Zool. Research, ii. (1917) pp. 95–6.
¶ Scottish Nat., No. 65 (1917) pp. 111–16.

species and variety, the source of the original description, and the distribution in the British Isles. In all, thirty-six species and thirty-five varieties are listed.

Annulata.

New Polychæts from Santander.*—Enrique Rioja describes *Clymene santanderensis* sp. n., giving details as to the cephalic plate, the parapodia and the setæ; *Lumbriclymene minor* Arwidsson; and *Phyllochætopterus solitarius* sp. n., which approaches in several respects *P. claparedii* M'Intosh.

Experiments on Earthworms.†—P. J. Schmidt and F. V. Stchepkina find that earthworms (*Allolobophora*) contain on an average 82·8 p.c. of water; that they can withstand exposure to a temperature of 0° C.; that the fatal temperature is between − 1·2° and − 2° C.; that they can lose 40 p.c. of their water without fatal consequences; and that partially desiccated specimens perished below − 1·2° C.

Nematohelminthes.

Life-history of Maupasina weissi.‡—L. G. Seurat has studied this Heterakid Nematode from the cæcum of *Elephantulus desertii*, a Macroscelid. The various stages in the development of the egg are noted. Out of the egg there emerges a larva, 400 μ in length, with a very distinct lateral membrane and two very refractive œsophageal glands. Before being hatched it shows a perforating needle on the upper lip.

The second stage, 2·7–3·4 mm. in length, shows two pairs of large cephalic papillæ, an excretory pore in front of the œsophageal bulb, two lateral caudal pores and a terminal caudal gland, two lateral cuticular alæ, a very short buccal cavity with three semicircular teeth, and an elongated œsophagus. This larval stage is found encysted in the cæcum.

After a moult a third stage is reached; they have a different shape of tail, no lateral alæ, a deep buccal cavity, and markedly developed gonads. The fourth larval stage shows a blood colour; the cuticle has two pairs of cephalic and two post-cervical lateral papillæ. A final moult leads to the adult phase, the female measuring 8·5–25 mm., the male 5–16 mm.

Affinities of Maupasina.§—L. G. Seurat discusses the affinities of a Heterakid Nematode, *Maupasina weissi* Seurat, which he described in 1913 from the cæcum of *Elephantulus deserti*. The female is remarkable

* Bull. Soc. Españ. Nat. Hist., xvii. (1917) pp. 221–8 (3 figs.).
† C.R. Soc. Biol. Paris, lxxx. (1917) pp. 366–8.
‡ Comptes Rendus, clxi. (1917) pp. 1017–19.
§ C.R. Soc. Biol. Paris, lxxx. (1917) pp. 350–4 (2 figs.).

for its bursa copulatrix, formed by a dorsal diverticulum of the distal region of the cuticular ovijector. The male shows a hemispherical prominence of the cuticle, situated about 60 μ in front of the upper margin of the cloaca. The genus is marked by the absence of lateral alæ, the position of the vulva, the vulvar ring, the bursa, the caudal alæ of the male, and the replacement of the pre-anal sucker by the prominence referred to. As regards the buccal cavity, the ovijector, the male genital papillæ, and the position of the caudal pores, it closely resembles *Allodapa*. There are also interesting resemblances of a less intimate kind between *Maupasina* and Strongylidæ.

New Genus of Nematodes from Birds.*—K. J. Skrjabin erects a new genus, *Seuratia*, for *Gnathostoma shipleyi* Stossich, from an albatross, which seems to be the same as *Rictularia paradoxa* Linstow, from an unknown host, and as *Acuaria pelagica* Seurat, from *Larus canus* and *Puffinus kuhli*. The diagnosis of the new genus is in the following terms:—Nematodes of the sub-family Acuarinæ; the head-region bears two short bands like curved epaulettes, which are supported on a thickened cuticle and have teeth on their free margin; behind the bands there is a pair of relatively enormous tricuspid hooks; the cuticle also bears two double rows of needles with the points turned backwards; the mouth has two lateral lips; the buccal cavity is tube-like; the vulva opens immediately in front of the mid-length of the body; the uteri are divergent; there are two unequal spicules, and four pairs of pre-anal papillæ; parasites of the alimentary canal of birds.

Nematodes from Birds of Prey.†—L. G. Seurat gives a careful description of both sexes of *Acuaria laticeps* (Rud.), from the food-canal of sparrow-hawk and barn-owl, and finds that the species is identical with *A. involuta* (Linstow). He also describes a new species, *A. affinis*, from the gullet of a barn-owl (*Strix flammea*). In the ornamentation of the head, the form of the ovijector, the arrangement of the genital papillæ of the male, this new species closely resembles *A. laticeps*, along with which it lives; but it differs in its robustness, the greater length of the recurrent branches of the cutaneous lines, the relatively shorter œsophagus, the position of the vulva about the middle of the body, the shorter tail of the male, and the details of the spicules. Indeed, the new species is like *A. noctuæ* in the form of the ovijector, the male papillæ, and the tendency of the recurrent lines to remain independent of one another.

Filariæ from Reptiles.‡—L. G. Seurat describes the third stage of the larvæ of *Filaria jubæ* nov. nom. (= *F. rubella* Rud, *Spiroptera bufonis* Stossich), found encapsuled in the thoracic cavity of *Zamenis hippocrepis* and *Trogonophis wiegmanni*. It is marked by the shortness of the

* C.R. Soc. Biol. Paris, lxxix. (1916) pp. 971–3.
† C.R. Soc. Biol. Paris, lxxix. (1916) pp. 1126–30 (2 figs.).
‡ C.R. Soc. Biol. Paris, lxxix. (1916) pp. 1131–6 (3 figs.).

œsophagus and by the exaggerated development of the excretory gland; it seems to be near *Filaria haje*, from the cobra; the adult is unknown. He also describes both sexes of *F. caudezei* Fraipont, from the subcutaneous connective-tissue and muscle of *Uromastix acanthinurus*. It is marked by the presence of lateral alæ, the shortness of the œsophagus, and the great development of the caudal alæ of the male. It approaches *Filaria furcata* Linstow, from the chameleon.

Nematodes from African Apes.*—Eduard Reichenow reports the occurrence of *Ankylostomum* in the gorilla, *Ascaris* in the chimpanzee, and *Microfilaria perstans* in both.

New Filaria from Lepus.†—L. G. Seurat describes both sexes of *Filaria numidica* sp. n., from *Lepus pallidior* and *L. kabylicus*. It is marked by the length and bluntly rounded shape of the tail, by the absence of caudal alæ, by the large number of pre-anal papillæ, and by the position of the vulva in the œsophageal region. It is very different from *F. scapiceps* Leidy, which occurs in several North American species of *Lepus*; it has the verrucose ornamentation of the cuticle seen in *F. loa*; it is in several ways near *F. circularis* Linstow.

Platyhelminthes.

Two Cestodes from Spotted Sting-Ray.‡—Edwin Linton describes from *Rhinoptera bonasus*, *Tylocephalum marsupium* sp.n., the first species to be recorded since the genus was established in 1887, and *Onchobothrium tortum* sp. n. from *Aetobatis narinari*. Both species were fastened to the mucous membrane of the spiral valve, which was somewhat ulcerated at the point of attachment of the onchobothria. The two new forms belong to quite different families, but they possess an interesting feature in common in the strongly fasciculated longitudinal muscle-layers.

Revision of Proteocephalidæ.§—George Roger La Rue has revised the Cestode family. Thirty-three species from fishes are dealt with and eighteen from amphibians and reptiles. A species of *Proteocephalus* may occur in different species of one genus, in different genera of the same family, and rarely more widely. The Proteocephalids are structurally allied to the Tetraphyllidæ and more distinctly to the Cyclophyllidæ. The suggestion is made that some member of the Bony Pike family (Lepisosteidæ) may have been responsible for the introduction of these Cestodes into fresh waters.

* Boll. Soc. Espãn. Hist. Nat., xvii. (1917) pp. 312–7.
† C.R. Soc. Biol. Paris, lxxx. (1917) pp. 354–7 (3 figs.).
‡ Journ. Parasitol., iii. (1916) pp. 34–8 (1 pl. and 2 figs.).
§ Contributions Zool. Lab. Illinois University, No. 33 (1916) 350 pp. (16 pls.). See Science, xliii. (1916) pp. 280–1.

Hepatic Distomatosis in Man.*—P. de Lavergne has added one to the short list of cases in which the presence of the liver-fluke in man has been detected in the life-time of the host. In this case the patient was a soldier invalided from the army with "intermittent fever." Microscopical examination of the fæces revealed the presence of the eggs of *Distomum* in considerable numbers. They were much more numerous in pale than in highly coloured fæcal matter, the number apparently varying in inverse ratio to the facility with which bile flowed into the intestines. Clinical symptoms—dysenteric troubles and bad general condition—had shown themselves seven years previously, when the patient was following his ordinary occupation of quarryman, and working in dark, damp tunnels. This fact recalls the observation of Perroncito on the frequent association, in the stools of workers in the St. Gothard tunnel, of the eggs of *Distomum* (in one case *D. hepaticum*) with those of *Ankylostomum*.

F. Mesnil has confirmed M. de Lavergne's diagnosis, and adds a note to the effect that, a few days before receiving material from him, he had observed the eggs of a small liver-fluke, *Dicrocœlium lanceatum*, which is still rarer in man than the large form. In his case the patient had been for a long time in the Congo, and recently with the forces in German East Africa.

Echinoderma.

Increase in Volume of the Nucleus of the Activated Ovum.†—M. Herlant has studied what has been repeatedly described, the considerable increase in the volume of the nucleus of the sea-urchin ovum after activation in cases of artificial parthenogenesis. He has made very careful measurements, chiefly bearing on *Strongylocentrotus*. These measurements show that the increase occurs in two distinct phases, separated by a period of decrease, a phase of depression. The hypertonic treatment ought to be applied during a phase of increase. During the depression the sensitiveness of the ovum is exaggerated, and leads to the formation of a number of accessory asters, which render effective segmentation impossible. Activation is a cyclical phenomenon, whose phases are mutually conditioned and lead on to a mitosis, the success of which depends on the intervention of another factor which has nothing to do with activation.

New Family of Asteroids.‡—W. K. Fisher establishes a new family, Metroderidæ, for the puzzling genus *Metrodira*. The whole skeleton is overlaid by a rather thin skin partially obscuring the outlines of the plates; the rays are slender; the abactinal plates are tesselate, partly imbricated with small spines; the marginal plates are large; the actinal

* C.R. Soc. Biol. Paris, lxxix. (1916) pp. 1098–9.
† Comptes Rendus, clxiv. (1916) pp. 412–5.
‡ Ann. Mag. Nat. Hist., xx. (1917) pp. 166–72.

intermediate plates reduced to one, between the mouth-plates and inferomarginals ; the papillæ are isolated, strictly abactinal ; the tube-feet have no calcareous deposits on the sucking-disk ; the ampullæ are single ; the interbrachial septa are practically absent.

Revision of Genera of Bourgueticrinidæ.*—Austin H. Clark has revised the recent genera of this Crinoid family, which is among stalked Crinoids the most widely represented. Genera occur in all the oceans, and range from 62 to 2690 fathoms. Besides *Rhizocrinus* and *Bathycrinus* it is necessary to recognize *Ilycrinus*, *Bythocrinus*, and *Democrinus*, and a new genus, *Monachocrinus*. In the new genus the arms divide once, on the second post-radial ossicle (being ten or twelve in number) ; all the post-radial ossicles are united in pairs by non-muscular articulation ; and the basals are separate, or are fused into a solid ring which is truncated conical, always longer than broad.

Cœlentera.

Minute Structure of Actinians.†—Manuel Sánchez y Sánchez describes in *Anemonia sulcata* and *Sagartia parasitica* the minute structure of the mesoglœa with its complex array of fibres, often disposed in glomeruli and spiral coils. He deals also with the glandular cells, the nematocysts, and other elements of the ectoderm.

Senonian Stromatoporella.‡—Yvonne Dehorne describes from the marine Senonian, near Martigues (Bouches-du-Rhône), massive colonies of Stromatoporoids. The laminæ and latilaminæ are very distinct, as also the transverse partitions or tabulæ. The characters correspond well with the diagnosis Nicholson gave of *Stromatoporella*, and the specific name *S. haugi* is proposed. Hitherto the genus has been recorded from Primary rocks.

Epithelio-muscular Cells of Hydra.§—G. Roskine discusses these elements, with two contractile basal prolongations which may attain a length of 0·38 mm. Each prolongation consists of a fibril and enveloping cytoplasm. The fibril consists of a delicate cylindrical membrane enclosing a fluid plasma (kinoplasm). Schneider was wrong in supposing that the fibril is made up of a number of still more delicate filamentar elements, but there seems to be one elastic skeletal filament in the interior of the kinoplasm.

* Journ. Washington Acad. Sci., vii. (1917) pp. 388–92.
† Boll. Soc. Españ. Hist. Nat., xvii. (1917) pp. 217–21 (4 figs.).
‡ Comptes Rendus, clxv. (1917) pp. 67–70.
§ C.R. Soc. Biol. Paris, lxxx. (1917) pp. 365–6.

Porifera.

Sponges from Malaga.*—Francisco Ferrer Hernández contributes some notes on interesting sponges from Malaga:—*Geodia cydonium*, *Ficulina ficus*, *Hymeniacidon mammeata*, *Ciocalypta penicillus*, *Halichondria albescens*, *Reniera densa*, and *Spongelia elegans*.

Protozoa.

Structure of Myonemes.†—G. Roskine has studied in particular the myonemes of *Stentor cœruleus*. Each contractile element lies in a canal with granular walls, relatively solid and elastic. The space between the walls of the canal and the myoneme itself contains a fluid. The plasma of the myoneme shows in life a hardly perceptible fibrilloid structure, which may suddenly resolve itself into drops. It is probable that the myoneme has a delicate solid membrane surrounding a contractile fluid kinoplasm. In *Climacostomum*, which is allied to *Stentor*, the myonemes have become solid, elastic, non-contractile cyto-skeletal filaments.

Mitochondria in Protozoa.‡—A. Alexeieff finds that all the differentiations in the cytoplasm of Protozoa are due to mitochondria. They are the formative "plasts," as in Metazoa. In some cases they have a nuclear origin, and are not to be separated off from chromosomes and chromidia. Like chromatin bodies, they can multiply at the expense of materials furnished by the cytoplasm. Even in cases like *Blastocystis enterocœla*, where the mitochondria seem to be independent of the nucleus, they may be regarded as phylogenetically dependent, as are also blepharoplasts. Cytoplasmic differentiation in general has a nuclear origin; the nucleus has a profoundly important morphogenic rôle. The large complex molecule of nuclear substance seems to give rise in the cytoplasm to much simpler substances, like lipoids, glycoplasts, amyloplasts. The parabasal body of Flagellates is to be ranked with glycoplast mitochondria. Flagella and cilia are to be referred back to the nucleus, with the blepharoplast as intermediary.

Mitochondria and Parabasal Body of Flagellates.§—A. Alexeieff advances reasons for regarding the parabasal body as mitochondrial in nature. In *Trypanosoma* the mitochondria are primarily situated in a vacuole in front of the kinetonucleus, and are afterwards diffused in the cytoplasm; the parabasal body is known as the kinetonucleus. In *Bodo* the parabasal body or kinetonucleus gives off siderophilous granules, probably glycoplast mitochondria, which form a chaplet. In *Cryptobia* the mitochondrial granules form a row along the undulating membrane. In a species of *Bicosœca*, Prowazek has described a single chromidium.

* Boll. Soc. Españ. Hist. Nat., xvii. (1917) pp. 228–90.
† C.R. Soc. Biol. Paris, lxxx. (1917) pp. 363–4.
‡ C.R. Soc. Biol. Paris, lxxx. (1917) pp. 361–3.
§ C.R. Soc. Biol. Paris., lxxx. (1917) pp. 358–61 (15 figs.).

In *Prowazekella* and *Tetramastix* (including part of *Monocercomonas*) there are granular perinuclear mitochondria of a glycoplastic nature. In *Monocercomonas* and *Polymastix* (which should be united) there are mitochondrial granules in front of or around the nucleus. In *Embadomonas* and *Chilomastix* there is an intranuclear cap of siderophilous granules, which, as Miss Mackinnon has noted, may be sometimes extranuclear; it is equivalent to perinuclear mitochondria. In *Protrichomonas* there are mitochondrial granules scattered in the cytoplasm, which often condense into a parabasal body apposed to the nucleus. In *Entrichomastix lacertæ* siderophilous granules form an incomplete perinuclear cupola; in *E. motellæ* there is the same, and the axostyle also bears mitochondrial granules. In *Trichomonas* the disposition of the mitochondrial granules is diverse, but specific. In *Hexamastix* there is a perinuclear corona; in *H. termitis* there are also endo-axostylar granules. In *Octomastix* g. n. (= *Hexamitus* pro parte) there are two median siderophilous granules. In *Octomitus intestinalis* the two axostyles are surrounded by a zone of minute dust-like mitochondria, which periodically produce glycogen.

Ecology of the Protozoa.*—Leon Augustus Hausman discusses the different types of Protozoan habitats and associations. Of great importance for the localization of species are—light, character of food, temperature of the water, chemical content of the water, presence or absence of enemies. In characteristic marsh pools the predominant forms are:—*Amœba limax*, *A. proteus*, *A. radiosa*, *Arcella vulgaris*, *Carchesium polypinum*, *Codonocladium umbellatum*, *Coleps hirtus*, *Difflugia acuminata*, *D. corona*, *D. globulosa*, *Euglypha alveolata*, *Oikomonas*, *Peridinium cinctum*, *Stylonichia mytilus*, *S. pustulata*, *Stentor polymorphus*, *Synura uvella*, *Trinema acinus*, *Vorticella microstoma*, and *V. nutans*.

In clear cold waters, lacking plant growths, with quartz and shale sands free from organic silt, the predominant forms are *Astasia*, *Holophrya*, *Holostichia vernalis*, *Nostolenus*. In clear flowing water with abundant plant life, with many diatoms, desmids, and Oscillatoria on the bottom, the predominant forms are *Amœba proteus*, *Chilodon cucullus*, *Chilomonas paramœcium*, *Colpidium*, *Colpoda inflata*, *Difflugia constricta*, *D. globulosa*, *D. lobostoma*, *Holophrya*, *Holostichia vernalis*, *Monas fluida*, *M. irregularis*, *M. dallingeri* (?), *Nostolenus orbicularis*, *Oxytrichia pellionella*, and *Prorodon teres*.

In clear small rock pools with abundant decomposing organic sediment, the predominant forms are *Chilodon cucullus*, *Chilomonas paramœcium*, *Coleps hirtus*, *Difflugia globulosa*, *Holophrya*, *Holostichia vernatis*, *Monas*, *Paramœcium bursaria*, *Trachelocerca olor*, and *Vorticella nutans*. Of a rarer form the author writes, "*Dileptus gigas* is surely the king of beasts among the ciliate Protozoa. It is entirely carnivorous and its appetite is apparently insatiable. The prey is stung by the well-developed trichocysts which *Dileptus* bears on its long 'neck,' and if too large to be swept into the buccal cavity by the cilia is forced in by writhings of the neck. The creature varies greatly in size, but is

* Amer. Nat., li. (1917) pp. 157–72.

normally about 450 microns in length. Individuals have been reported measuring 800 microns!"

A fifth environmental type consists of ditches and pools choked with heavy luxuriant masses of algæ, and exposed to the sun during the entire day. The predominant forms are :—*Cercomonas terma*, *Chlamydomonas*, *Difflugia globulosa*, *Euglena viridis*, *Monas fluida*, *M. irregularis*, *Peridinium cinctum*, *Synura uvella*, and *Trepomonas agilis*.

Blood-parasites of African Apes and Monkeys.*—Eduard Reichenow deals with *Laverania malariæ* (the cause of paludism) in the chimpanzee; with trypanosomes (*T. lewisi primatum*) from *Cercopithecus cephus*, *Perodicticus*, and the chimpanzee; with *Troglodytella gorillæ* sp. n., a remarkable Ophryoscolecid Infusorian from the colon of the gorilla; and with a new sub-species of *T. abrassarti*, from the chimpanzee.

Cysts of Entamœba dysenteriæ.†—C. Mathis and L. Mercier describe this stage, which is marked by the presence of four nuclei and often by a rod-like chromidium. Full information is given as to dimensions, and it is shown that there are macrocysts and microcysts with precisely similar histories. The development of the four nuclei from one is described. There is no emission of chromatin from the nucleus, as Hartmann described. If there is any sex-phenomenon it probably occurs after the ingestion of the cysts and the liberation of their contents. It is possible that the microcysts and macrocysts are gametocytes giving origin to gamete-amœbæ of two sexes.

Division of Entamœba dysenteriæ.‡—C. Mathis and L. Mercier find that this parasite multiplies solely by simple division. There is no multiple division or schizogony, as has been asserted. There is a mitosis, effected within the nuclear membrane (a "mesomitosis" in Chatton's terminology). There must be a very rapid division of the cytoplasm, but it was not observed.

Entamœba from Dipteron Larva.§—D. Keilin describes a new Entamœba (*E. mesnili*, sp. n.) which lives as a parasite in the intestine of the larva of *Trichocera hiemalis* and *T. annulata*. This entamœba resembles other known forms in its parasitic mode of life, in its large pseudopods and in the absence of contractile vacuoles. It differs from them in the presence of several nuclei throughout the whole vegetative phase, and of adhesive protoplasm on its posterior margin. The investigator recalls the fact that many authors have refused to recognize plurinuclear vegetative forms leading on to multiple schizogony, as described by Councilman and Lafleur for *E. dysenteriæ*, and have interpreted them either as forms leading towards the sporogonic cycle, or as degenerate. Doubt has recently been expressed by James as to the

* Boll. Soc. Españ. Hist. Nat., xvii. (1917) pp. 312–34 (2 pls. and 1 fig.).
† C.R. Soc. Biol. Paris, lxxix. (1916) pp. 980–2.
‡ C.R. Soc. Biol. Paris, lxxix. (1916) pp. 982–4.
§ C.R. Soc. Biol. Paris, lxxx. (1917) pp. 133–6.

occurrence of schizogony in *E. coli*, and the only well-established case of plurinucleate vegetative forms leading to schizogony by successive bi-partitions is that of *E. ranarum* Grassi, cited by Collin. But these cases of schizogony occur only at certain periods of the cycle; they are not frequent, and they have not been seen by other eminent protozoologists who have studied the species. The plurinuclearity of *E. mesnili*, therefore, finds a parallel only among amœbæ of the Pelomyxidæ group, or among certain terricolous amœbæ with a pellicle like *A. fibrillosa* Greeff or *A. alba* Greeff.

The author promises details of nuclear division and the sporogonic cycle in a later paper.

Study of Noctiluca.*—Ethel Browne Harvey finds that the specific gravity of *Noctiluca* is less than that of sea-water; it must have a lower salt-content than the sea-water; the plasma membrane has the usual semi-permeability towards the balanced salts of sea-water, i.e. permeability to water and impermeability to salts; it can lessen and increase its specific gravity in a regulatory fashion.

The luminescence requires stimulation; it comes from granules in the protoplasm; it requires oxygen; it is normally a momentary bright flash; dying animals and anæsthetized animals produce a steady glow; completely broken specimens glow but do not flash.

Anæsthetized specimens always give some glow, unlike luminous bacteria whose light-giving power can be completely anæsthetized. Experiments show that the anæsthetic attacks the mechanism of the utilization of oxygen in the cell, and not the permeability of the cell membrane for oxygen.

Cycle of Monocystis michaelseni.†—Olga Tolosani has studied the life-history of this Gregarine from the cœlom of *Pheretima heterochæta*. In the genital organs there was another Gregarine, probably *Stomatophora coronata* Hesse. The trophocytes of *M. michaelseni* were free, the other stages were found in the segmental phagocytic organs where they seemed to flourish. A description is given of the phenomena preceding the purification of the nucleus, the process of purification, the chromatin reduction and the process of division, the formation of gametes, and the occurrence of anomalous encystations. The minute structure of the adult is dealt with. The figures have unusual excellence.

Sexual Stages of Sarcocystis muris.‡—Howard Crawley has studied the life-history of this sporozoon. The spores ingested by a mouse may reach the posterior part of the small intestine within one hour and invade the epithelial cells. Within the lumen the spore changes rapidly. The nucleus becomes larger and more conspicuous, and a distinct nuclear net

* Proc. Nat. Acad. Sci. U.S.A., iii. (1917) pp. 15-16.
† Monitore Zool. Ital., xxvii. (1916) pp. 217-22 (2 pls.).
‡ Proc. Acad. Nat. Sci. Philadelphia, lxviii. (1916) pp. 2-43 (5 pls.).

becomes evident. The granules characteristic of the spore as it occurs in the cyst either disappear or become much less evident. The spores are sexually differentiated, but it does not appear to be possible, at the outset, to distinguish between the males and the females.

Within the cells of the mouse, the changes undergone by the male spores, or microgametocytes, began to be evident in one and a half to two hours. The size of the nucleus increases further; the nuclear net is further developed; the cytoplasm degenerates and disappears in about six hours. The microgametocyte is reduced to its original nucleus, which, however, is of approximately the same size as the original spore. The reduction of the cytoplasm is a very remarkable phenomenon.

Three internal changes go on more or less simultaneously. The chromatin appears to suffer a loss in actual bulk, and alters in staining reaction from acidophil to basophil. The chromatin, which occurred in large irregular masses or distributed along the threads of the linin net in strips or bands, is reduced to granules which become smaller and smaller and show a greater and greater affinity for chromatin stains. These granules finally assemble in clusters around the periphery.

The next step is the solidification of these granular clusters into rounded solid balls. These elongate into minute thread-like bodies, the microgametes. These are found at their acme in mice killed eighteen hours after inoculation.

The females go through their development side by side with the males, but there are no such conspicuous changes, and the early female stages are much like the spore which has just entered the cell. In the course of a few hours, however, the females can be picked out, appearing as broadly oval cells, relatively shorter and broader than the original spores. The cytoplasm is all retained and assumes a rather dense alveolar texture. The nucleus shows no evident increase in size. The nuclear net does not develop as it does in the male parasite, but the chromatin concentrates into a single large karyosome, which maintains an acidophil rather than a basophil staining reaction.

In the six to fifteen-hour period phenomena occur which may be regarded as maturation. Irregular chromatin granules appear in close association with the nuclear membrane. These granules subsequently pass out into the cytoplasm, and finally disappear.

The mature female, or macrogamete, may be found in mice killed from eleven to eighteen hours after inoculation. Finally, in the eighteen-hour stages, macrogametes may be found which in some cases show minute, thread-like bodies upon their surface, and in others contain within their substance small solid chromatic bodies, one in each case. Fertilization has occurred.

Zoological Position of Sarcosporidia.*—Howard Crawley discusses the idea that the muscle stage of *Sarcocystis muris* is not an individual but a congeries or colony of individuals. In other words, the unit is not the cyst or Miescher's tube, but the sporoblast itself.

* Proc. Acad. Nat. Sci. Philadelphia, lxviii. (1917) pp. 379–88.

Assuming that this is true, the life-history of *Sarcocystis muris* would be as follows:—The ingested spores gain the epithelium of the intestine and develop into the macrogametes and microgametes. The latter fertilize the former and produce the zygotes. By endogenous multiplication the zygotes produce a number of minute elements. There is here a gap in the life-history. Two divergent lines are followed, for some phases appear in the fæces and others in the muscles. The form that invades the muscle is either the sporoblast itself or its immediate forerunner, which may be the zygote or some element derived from the zygote. In any event, at a certain point in the history, the muscle cells come to harbour individual sporoblasts. These divide many times by bi-partition, but eventually the products of these divisions are no longer sporoblasts, but spores. Unless its development be interfered with, each sporoblast will presumably produce a cyst.

This life-history is compared in detail with that of a typical member of the Coccidiomorpha. The Sarcosporidian "spore" is the homologue of the Coccidiomorphan merozoite. The sexual stages are alike. The multiplication products of the Sarcosporidian zygote are presumably the homologues of either the spores or sporozoites of the Coccidiomorpha. The sporoblast is not so easy to place. It may correspond either to the sporozoite or to the trophozoite of the Coccidiomorpha. The Sarcosporidian muscle stage is comparable to the entire schizogonous cycle of the Coccidiomorpha. In the latter, the products of schizogony are set free and are enabled to invade new regions of the host. In the former, a tissue reaction on the part of the host confines them to the region originally invaded.

If the line of reasoning indicated be sound, the Sarcosporidia are not Neosporidia, but Telosporidia, and moreover Telosporidia which belong to the Coccidiomorpha. The Sporozoa may be divided into two sub-classes, Telosporidia and Neosporidia. In the first, division into multiplicative elements takes place only at the end of the vegetative period. In the second, growth and spore-formation take place simultaneously.

The re-classification proposed reads as follows:—

Class SPOROZOA.

Sub-class I. TELOSPORIDIA.
- Order 1. Coccidiomorpha.
  - Sub-order A. Coccidia.
  - ,, B. Hæmosporidia.
  - ,, C. Sarcosporidia.
- Order 2. Gregarinida.

Sub-class II. NEOSPORIDIA.
- Order 1. Cnidosporidia.
  - Sub-order A. Myxosporidia.
  - ,, B. Microsporidia.
  - ,, C. Actinomyxidia.
- Order 2. Haplosporidia.

New Hæmogregarine in Man.*—Armand Krempf describes, from the blood of the hypertrophied spleen of a young Chinaman from Tien-Tsen, a new parasite which he names *Hæmogregarina hominis* sp. n. It is represented in the blood of the spleen by vermicular and rod-like sporonts, sometimes in the red blood-corpuscles, sometimes free. The infected corpuscle swells up and shows excentrically a relatively large capsule (5 μ by 10 μ) containing a vermicular sporont bent upon itself. This sporont divides into two of unequal size. No young forms nor schizogonic forms were seen. The case is at present unique.

* Comptes Rendus, clxi. (1917) pp. 965-7.

BOTANY.

CRYPTOGAMS.

Pteridophyta.

(By A. Gepp, M.A., F.L.S.)

New Goniopteris from Middle Eocene.*—E. W. Berry describes a new species of fossil *Goniopteris*, from the Middle Eocene, giving it the name *G. claiborniana*; it occurs rather commonly in some Tertiary clays of Louisiana and Mississippi. He discusses the venation of the typical pinnæ with care, and points out the differences to be found in pinnæ with shallow and deep lobulation of the margin respectively.

Lycopodiaceæ of Sweden.†—H. V. Rosendahl publishes a systematic account of the Lycopodiaceæ of Sweden, with diagnoses of all the varieties and forms, several of which are new to science, and illustrates most of them with photographs. *Lycopodium alpinum* has one variety; *L. annotinum* three vars. and twelve forms; *L. clavatum* three vars. and eleven forms; *L. complanatum* one sub-species and eleven forms; *L. inundatum* one var. and one form; *L. Selago* six vars.; *Isoëtes lacustris* four vars. and five sub-vars.

Bryophyta.

(By A. Gepp.)

Development of Archegonium in Catharinea.‡—G. S. Bryan gives an account of the development of the archegonium of *Catherinea angustata* Brid., with special reference to the origin of the canal row in mosses, since, as he shows, the views of previous authors are very contradictory. The summary of his results is as follows:—1. The archegonia of *C. angustata* begin to develop in April. 2. The first-formed archegonium arises from the apical cell region, but whether from the apical cell itself or from one of its immediate segments must be determined later. 3. In the earlier stages of development the young archegonium is formed by the activity of an apical cell with two cutting faces, producing a filament of a few cells. 4. The archegonium proper is initiated by the appearance in the terminal cell of three oblique walls,

* Bull. Torrey Bot. Club, xliv. (1917) pp. 331–5 (1 pl.).
† Svensk. Bot. Tidskrift, xi. (1917) pp. 39–59 (figs.).
‡ Bot. Gaz., lxiv. (1917) pp. 1–20 (8 pls. and 1 fig.).

cutting off three peripheral segments and originating the primary axial cell within, which on division gives rise to the cover cell and the central cell. 5. The central cell on division forms the primary neck canal cell and the ventral cell. 6. The cover cell is active for a time, cutting off peripheral segments for the outer cells of the neck and basal initials for the canal row. 7. The number of basal initials varies, but is at least three in *C. undulata*. 8. The cells of the canal row and the peripheral cells of the neck grow by intercalary divisions, and in any order. 9. The major growth of the archegonium is intercalary. 10. The cells of the neck canal row have a double origin. The lower are formed by the intercalary divisions of the primary neck canal cell ; the upper through the intercalary divisions of the three or more initials cut from the base of the cover cell. 11. The ventral cell divides relatively early into ventral canal cell and egg. 12. The ventral canal cell is variable in size. 13. The mature archegonium has usually more than fifty neck canal cells, and may contain as many as eighty-six. 14. The canal row is generally multiple in its upper part, and occasionally throughout. 15. The disintegration of the canal row is acropetal, but does not involve the ventral canal cell. 16. If the number of neck canal cells is an indication of primitiveness, the most advanced group of the mosses (Polytrichaceæ) has the most primitive archegonium yet described among the Bryophyta.

Spermatogenesis of Polytrichum juniperinum.*—C. E. Allen, having previously described the "Cell-structure, Growth, and Division in the Antheridia of *Polytrichum juniperinum*"† as far as the formation of the androcyte mother-cells, now treats of the metamorphosis of the androcytes into antherozoids. 1. Each newly formed androcyte contains a small rounded blepharoplast which behaves like a centrosome in the division of the androcyte mother-cell, and is situated where recently was a spindle pole. 2. This blepharoplast elongates, places itself in contact with the plasma membrane, and ultimately forms a long, peripherally placed, curved cord ; and two long cilia grow out from it, being attached to it a little behind its anterior end. 3. The nucleus moves into contact with the blepharoplast and stretches out alongside it. The blepharoplast ultimately becomes indistinguishable from the nucleus, save at its projecting anterior end. The nucleus becomes a long, slender, coiled, finally homogeneous body, of about one and a half turns ; and with the blepharoplast it seems to constitute the whole antherozoid. 4. When the blepharoplast begins to elongate, a large spherical body, the limosphere, appears, variously situated in the cytoplasm ; and soon it approaches the anterior end of the blepharoplast. It then divides unequally, the smaller portion becoming the apical body, and the larger remaining unchanged and retaining the name of the limosphere. 5. The apical body long remains in evidence, but does not appear to form part of the antherozoid. 6. The limosphere becomes placed in contact with the posterior portion of the nucleus, and persists in the cytoplasm until

* Ann. Bot., xxxi. (1917) pp. 269–91 (2 pls.).
† Arch. f. Zellforsch., viii. (1912) p. 121.

the antherozoid is mature. 7. During certain stages another conspicuous cytoplasmic body, called the *percnosome*, because of its staining properties, seems to be regularly present. It is probably identical with a smaller granule which is generally recognizable both at an earlier and at a later period. This smaller body sometimes lies in a rather large vacuole. 8. At this time the androcyte is approximately spherical, but becomes lenticular as the cytoplasm decreases. Part of the cytoplasm with the limosphere remains included within the curve of the posterior end of the mature antherozoid. 9. The walls that separate the androcytes become dissolved. The mature antherozoid lies in a vesicle which, as the contents ooze out of the antheridium, *appears* to be bounded by a distinct outline, though in fixed material no trace of such a membrane is to be found at this late stage. The separate vesicles are imbedded in a viscous substance which probably is derived from the material of the broken-down walls.

Illustrated Key to Ditrichaceæ.*—T. C. Frye publishes an illustrated key to the Ditrichaceæ of America west of the Rocky Mountains between Mexico and the Arctic Ocean. The number of species concerned is sixteen, half of which belong to *Ditrichum*. The other five genera are *Pleuridium*, *Swartzia*, *Trichodon*, *Ceratodon*, *Saelania*. Figures are given of the leaf-structure of each species and of the peristome characters. The keys provide for the determination of both genus and species, whether fertile or sterile.

Tasmanian Hepaticæ.†—L. Rodway publishes a systematic account of the Tasmanian Hepaticæ, which, issued separately, provides a handbook to this group of plants. Descriptions of all the orders, families, genera and species are given; and, by the insertion of keys to the genera and species, the determination of specimens is much facilitated. The number of species approaches 300, which means a very rich flora.

New Tasmanian Bryophyta.‡—L. Rodway describes some additions to the Bryophyte flora of Tasmania, namely, three mosses and nine Hepaticæ. Ten of these are new to science, as also probably is the moss referred to *Blindia acuta*, for it differs from the type in its leaf-structure. The nine new Hepaticæ represent eight genera.

Philippine Mosses.—R. S. Williams publishes a list of 240 mosses collected by him in 1903–5 in the Philippine Islands, Luzon and Mindanao. These fall into 118 genera. The author gives descriptions of 27 new species and three new genera, the structure of some of which is figured in the plates. The new genera are *Rhabdoweisiella*, *Pseudopohlia*, and *Stereodontopsis*.

* Bryologist, xx. (1917) pp. 49–60 (16 figs.).
† Proc. Roy. Soc. Tasmania for 1916 (Hobart, 1917) pp. 51–143.
‡ Proc. Roy. Soc. Tasmania for 1916 (Hobart, 1917) pp. 44–7.
§ Bull. New York Bot. Gard., viii. (1917) pp. 331–78 (4 pls.).

Thallophyta.

Algæ.

(By Mrs. E. S. Gepp.)

New Epiphytic Flagellates.*—J. Pavillard describes two new Flagellates, epiphytic on pelagic diatoms. One, *Solenicola setigera*, is the type of a new genus, and has been described, though without a name, by Gran in 1902, and by Mangin in 1913. It is epiphytic on *Dactyliosolen*. The organism is described in detail. The genus *Solenicola* is most closely allied to *Oikomonas*. The second flagellate is *Bicœca mediterranea* Pav., and was found plentifully on *Cerataulina Bergonii*, *Chætoceros anastomosans*, *Nitzschia seriata*, and *Skeletonema costatum*.

Australian Fresh-water Plankton.†—G. I. Playfair publishes a list of Fresh-water Phytoplankton (Protococcoideæ) which has been collected at intervals during the past ten years from the suburbs of Sydney, and from the neighbourhood of Lismore on the Richmond river. A few records are also included from still earlier up-country gatherings at Collector, and from certain samples which have been received from places outside the State of New South Wales. The author revises also the nomenclature of some of the plankton-forms noted in "Plankton of the Sydney Water-Supply."‡ The term plankton has been taken in a wide sense to include material found floating in the water of river, lake, lagoon, or pond, or shaken out of weeds in some depth of water. One new genus is described, *Bernardia*, which contains two species formerly included in *Lagerheimia*. The new species number eighteen, and the new varieties thirty-seven. Critical notes are appended to many of the records.

Pelagic Diatoms of the Gulf of Lyons.§—J. Pavillard publishes some researches on the pelagic diatoms of the Gulf of Lyons, and gives a list of the species recorded. He adds interesting general observations on epiphytism in pelagic diatoms, and the general aspect and periodic evolution of diatomaceous plankton, with useful biological notes.

Mastigocladus laminosus.‖—L. Buscalioni has investigated the ramification of *Mastigocladus laminosus*, collected at the Baths of Valdieri. He reviews and criticizes the work of Prof. Borzi on the subject in his studies on Myxophyceæ, and then describes his own results, which he summarizes as follows:—*M. laminosus* possesses both true and spurious ramification. The former, however, in consequence of cellular dislocation arising during the formation of branches and flagella, often

* Comptes Rendus, clxiii. (1916) pp. 65–8 (figs.).
† Proc. Linn. Soc. New South Wales., xli. (1917) pp. 823–52 (4 pls.).
‡ Proc. Linn. Soc. New South Wales, 1913, pp. 512–52.
§ Trav. Inst. Bot. Univ., Montpellier et Stat. Zool., Cette sér. mixt. Mém. 5 (1916) 63 pp. (2 pls. and 5 figs.).
‖ Malpighia, xxviii. (1917) pp. 83–96.

pass over into the latter, which are much more rare than would appear at first sight. The true nature of the branches reveals itself for the most part only in the earliest stages of their evolution. The flagella which result from them consist of a single filament of cells or, at the base, two rows of united cells, neither of which must be considered as an abortive branch.

Sexuality of Spirogyra.*—B. Cunningham discusses the question of sexuality in *Spirogyra*, and comes to the following conclusions: 1. Bisexuality of the filament does occur in certain species of *Spirogyra*, but not necessarily in all species. 2. Reduction may occur in the zygote, in which case a filament wholly of one sex arises, or reduction may occur just previous to reproduction, in which case none of the nuclei degenerates, and filaments of a bisexual nature are produced, which would conjugate either laterally or by cross-conjugation. 3. Cell-division may take place subsequent to reduction, some cases showing three divisions, and this is an essential difference between lateral and cross-conjugation, since the latter may continue cell-division after reduction is complete, but the former apparently does not. 4. The filament of *Spirogyra*, in the species examined and in those with lateral conjugation, is homologous with the sporophyte of higher plants. The species examined showed some of the characteristics of *S. inflata*, but differed from it in certain particulars. It may therefore be a new species.

Dictyosiphon fœniculaceus.†—C. Sauvageau writes on a new type of alternation of generations in Brown Algæ, as exemplified by *Dictyosiphon fœniculaceus*. More than forty years ago Areschoug described a conjugation between germinations of zoospores in *D. hippuroides*, but his work has never been either confirmed or contradicted. The material of *D. fœniculaceus* for the present research was sent by M. Corbière from Cherbourg to the author in September 1916, and he then started some cultures. Some of the filaments fruited after more than five months of culture, at the end of February, and these were the gametophyte of *Dictyosiphon*. Dehiscence takes place at all hours of the day. The zoospores, about 7 μ by 4 μ, having a single chromatophore and a red spot at the insertion of the cilia, become fixed on the side opposite to the window, and round themselves off with a diameter of about 4·5–5 μ. The germination of the embryospores is general and almost immediate. Twenty-four hours later a creeping tube is produced, one to three times as long as the diameter, and 2 μ wide. This prothallus elongates rapidly; after three days it has already one or two cross-walls. At no period does conjugation take place, as described by Areschoug. Three weeks later the prothallus measures 100–300 μ, and it has emitted here and there creeping branches in various directions. Some of its cells are long and slender, others are short and stumpy. The embryospore remains distinct, or enlarges and produces a branch. Growth and ramification continue, and towards the fifth week there appear long sessile colourless hairs, 3–4 μ wide. The

* Bot. Gaz., lxiii. (1917) pp. 486–500 (3 pls.).
† Comptes Rendus, clxiv. (1917) pp. 829–31.

largest prothallia attain a diameter of about 1 mm.; their long cells are 5 μ wide; the short cells, which have become torulose, are 6–10 μ wide. Each possesses one or two chromatophores, a nucleus, one or two droplets of oil, and some very small globules of fucosan. At the end of February appeared narrow plurilocular gametangia, cylindrical, obtuse, preferably on the torulose cells. They are composed of two to twelve uniseriate locules, often three or four, the lower one sometimes belonging to the filament itself. Each locule encloses a single gamete, with superior or lateral chromatophore, and very distinct red spot. The walls separating the locules disappear before dehiscence, and the gametes round themselves off. Dehiscence is terminal and fairly slow. The gametes, scarcely differing from zoospores, measure about 6 μ by 4 μ. Thus the prothallus of *Dictyosiphon* resembles a *Streblonema*. While examining the prothalli the author has often watched dehiscence. Most of the gametes hardly escape from the network of filaments. An hour later they come to rest, become rounded, and disaggregate. In cellular cultures they move away from the window, but the small number in each gametangium and their dehiscence at any hour of the day are not favourable factors for the observation of fecundation. Some are destroyed, others, parthenogenetic, become enclosed in a membrane, and then measure 4 μ. Among the latter, certain rounded globules, rather larger and possessing a nucleus, two chromatophores and two red spots, can be nothing but zygotes; isogamy takes place, no doubt, as in *Ectocarpus siliculosus*, between a stationary and a motile gamete.

The germination of the zygotes and the parthenogenetic gametes, preceded by an increase of diameter which soon prevents the distinguishing of one from the other, takes place shortly. A creeping filament is emitted, and, at the extremity of the same diameter, a long colourless erect hair. The filament elongates, branches, produces hairs, and resembles a small prothallus. Towards the end of April, certain cells divide, and produce a small projecting piliferous mass which soon takes the form of a narrow pyramid of cells with external rounded wall. When this pyramid reaches 100–150 μ its uniseriate summit elongates by means of its terminal cell, and shows the characteristic division of *Dictyosiphon*. The germination of the zygotes on the parthenogenetic gametes provides therefore a protonema, which bears plantlets. The cycle of vegetation of *Laminaria* round our coasts comprises a heterogamous diœcious gametophyte, and a sporophyte or true *Laminaria*. That of *Dictyosiphon* comprises an isogamous gametophyte, probably monœcious, a microscopic protonema, and a sporophyte or true *Dictyosiphon*. Nothing similar has been recorded for the Brown Algæ.

Dumontia filiformis.*—G. A. Dunn has made a special study of *Dumontia filiformis* which she found at South Harpswell, Maine, in 1913. She describes the plant fully in all details, externally and internally, and finally summarizes her results, for which in full the original paper must be consulted. The vegetative structure is of a type occurring in many families of the Florideæ. Growth is apical throughout the entire thallus.

* Bot. Gaz., lxiii. (1917) pp. 425–67 (4 pls.).

The development of the tetraspores and spermatia is described. The carpogonial branch arises as a lateral outgrowth of a large subcortical cell. A mature carpogonial branch consists of six or seven cells and a trichogyne. The basal cell sometimes divides to form a lateral cell. Each carpogonial branch which has been fertilized produces two or three sporogenous filaments, all of which arise from one cell. It is thought that the nuclei in these filaments are descended from the fusion nucleus in the carpogonium. The sporogenous filaments grow out towards the auxiliary cell branches. The auxiliary cell branches in origin, distribution, structure, and mode of development are very similar to the carpogonial branches. Only about one auxiliary cell-branch is initiated to every seven carpogonial branches. The time of initiation of the former is a little later than that of the latter. The mature auxiliary cell-branch consists of four to seven cells. The second or third cell of the branch is the auxiliary cell. The original nucleus in the auxiliary cell takes no part in the formation of the carpospores. The nuclei in the carpospores are descended from the nucleus which enters the auxiliary cell from the sporogenous filament. In the development of the carpospores and cystocarps three or four gonimoblast filaments arise from the auxiliary cell. Every cell of these filaments forms a spore. There are about twenty carpospores in each cystocarp. Mature carpospores are usually uninucleate, well filled with a cytoplasm, and contain chromatophores, which are similar to those of the vegetative cells. In the resting nucleus of *Dumontia* all the chromatin is in the nucleolus. The nucleolus often contains a vacuole. The chromatin in preparation for mitosis passes out of the nucleolus, and in the form of small granules becomes distributed along the linin net. The net disappears and the granules become massed together to form larger units, chromosomes. The number of chromosomes was not definitely determined, but was apparently about seven. No spireme or spindle was seen. After division, the chromatin is again found massed in the nucleolus.

Calcareous Algæ from Malta.*—C. Samsonoff-Aruffo describes certain calcareous algæ collected from the Upper Coralline Limestone in Malta. The first of these, *Lithophyllum Destefanii*, a new species, is described in detail. The thallus forms numerous thin laminæ, which are superposed and united by small bands of cemented sand. The hypothallus and perithallus are clearly to be distinguished, and show the characters of *Lithophyllum*. The thallus is sterile. It is most closely allied to *L. lichenoides* and *L. Fosliei*. Another species was collected in the Lower Coralline Limestone It forms part of a mixture of incrustations and of very short swollen branches closely united by a basal calcareous mass. When separated out, the alga shows a hypothallus which is but slightly developed, though always present, and of the type of *Lithothamnium*. The perithallus is more developed, very compact and regular, composed of vertical cellular columns of very small cells. The structure is described in detail. The alga, which is most closely allied to *L. compactum*, is called by the author, *L. miocenum*, a new

* Atti (Rend.) R. Accad. Lincei Roma, xxvi. (1917) pp. 610–6.

species. Other species recorded are *L. intermedium* Kjellm., *Goniolithon Martellii* Sam., *Lithothamnium* sp., and *Archæolithothamnium* sp.

Marine Algology.*—A. Mazza continues his studies of Marine Algæ, and finishes the genus *Lithothamnium*. He treats of the following genera, which also belong to the Corallinaceæ, and discusses their morphology and structure :—*Choreonema* (1 sp.), *Melobesia* (4 sp.), *Goniolithon* (1 sp.), *Dermatolithon* (2 sp.), *Lithophyllum* (6 sp.), *Tenarea* (1 sp.), *Mastophora* (2 sp.)

Marine Algæ of California.†—N. L. Gardiner publishes the first of a series of papers on New Pacific Coast Marine Algæ, and describes two genera, eight species and two forms all new to science. *Arthrospira maxima* is a special filamentous green alga, remarkable for thriving in sea-water which several times a day becomes heated to 60° C., being employed for condensing steam in an electric power-house. *Chlorochytrium Porphyræ*, an endophytic unicellular green alga, occurs in myriads within the thick gelatinous walls of *Porphyra* ; its structure, life-history and affinities are discussed at length. *Gayella constricta* grows associated with *Prasiola*, but is certainly not a metamorphosed form of the latter, despite the views of some authors. Of the brown algæ, *Sargassum dissectifolium* is demonstrated to be distinct from the Japanese *S. piluliferum*, to which it had been referred. *Cystoseira neglecta* had previously been known by floating fragments only, and has now been traced to Santa Catalina Island. The limits and distinguishing characters of the genera *Cystoseira* and *Cystophyllum* badly need to be critically revised. The red algæ are of much interest. *Petrocelis franciscana* is the most abundant rock-encrusting alga on the Californian coast, and has been wrongly referred to *P. Middendorfii*, of the Ochotsk Sea. *Hildenbrandtia occidentalis* is also an encrusting alga widely distributed along the coast ; and the ample fruiting material that has been collected permits it to be adequately described ; but there is still some question whether it be generally distinct from *Besa* Setchell (1912). *Coriophyllum expansum* is an encrusting alga of leathery texture, forming a new genus placed provisionally in the Squamariaceæ until its sexual organs are discovered. *Cumagloia Andersonii* has hitherto been regarded as a species of *Nemalion*, but is now made the type of a new genus owing to the method of origin and the structure of the cystocarp. Structural details of the various species are figured in the five plates.

Japanese Marine Algæ.‡—K. Yendo publishes the sixth part of his Notes on Algæ new to Japan, and clears up many doubtful points concerning the species therein recorded. Among these are two species of *Liagora*, of which specimens are in the Dublin Herbarium, examined by the author. Under *Gymnogongrus leptophyllus* the differences between that species and *G. japonicus* are pointed out, the two having been often confused. Two varieties of *Iridæa laminarioides* are described (three are figured), with the synonymy of each, and important notes and

* La Nuova Notarisia, xxviii. (1917) pp. 176–239.
† Univ. California Publications, Botany, vii. (1917) pp. 377–416 (5 pls.).
‡ Bot. Mag. Tokyo, xxxi. (1917) pp. 75–95 (figs. in text).

criticisms. In Japan, species of *Iridæa* are used for sizing textiles and other purposes. *Iridæa pulchra* is shown to be a valid species. Critical and illuminating notes of the highest value are given in the following species :—*Sarcodia Montagneana*, two species of *Hypnea*, *Chrysymenia Enteromorpha* (which is also figured), *Laurencia heterocladia*, *Pleonosporium venustissimum*, *Schizymenia Dubyi* (= *S. Binderi* J. Ag.), *Nemastoma laciniata*, and others.

Fungi.

(By A. Lorrain Smith, F.L.S.)

Peronospora on Hemp.*—Vittorio Peglion found a fine growth of this parasite on hemp plants in Ferrara. He therefore made a thorough study of its life-history. He notes the method of attack and the sequence of leaves to succumb to the parasite ; and he discusses the stages at which infection takes place.

Cultivation of the spores revealed the fact that these on germination produce zoospores, about three zoospores in each conidium ; they swarm for an hour or two, then loose their cilia and become more spherical, after which germination by a tube takes place. Peglion has therefore placed the fungus in the genus *Peronoplasmopara*.

Study of Mucor.†—A. H. W. Povah is studying the genus *Mucor* with a view to determining the species with more certainty, having regard to their morphological characters and their cultural reactions. He gives an account of work done by others and of the methods used by them, and also gives a sketch of the taxonomic problems and of the systems adopted by previous fungologists.

An account is then given of his own methods of study, the collection of material, the herbarium material consulted, and the cultures undertaken. He found that, on the whole, complex substances such as bread formed the most suitable media.

In a second paper ‡ the author takes up the question of classification. He rejects the method of arrangement according to branching of the sporophores, as the spores themselves give more satisfactory characters. Eighteen species are described, several of them new to science.

Studies of Rhizopus nigricans.§—U. E. Stevens and L. A. Hawkins have studied this mould in its relation to the "leak-rot" it causes on strawberry fruits. In accounting for the loss of juice occurring in strawberries attacked, the authors seem to think that "the fungus so affects the protoplasm of the cell, perhaps by secreting some toxin, that it is no longer capable of functioning as a semi-permeable membrane."

* Atti Real. Accad Lincei, cccxiv. (1917) pp. 618–21.
† Bull. Torrey Bot. Club, xliv. (1917) pp. 241–59.
‡ Bull. Torrey Bot. Club, xliv. (1917) pp. 287–313 (4 pls.).
§ Phytopathology, vii. (1917) p. 178–84.

The cell walls are seldom pierced, and the protoplasm is only slightly altered in appearance; the nuclei remain unaltered until the cells are crushed.

L. A. Hawkins * has also published an account of "leak" in potatoes due to the same fungus and to *Pythium de Baryanum*, the latter being the most common origin of the disease. It is of considerable importance in California, and appears soon after harvesting in warehouses, etc. At first there is a small discoloration round a wound which spreads over the whole surface, and the tissues soon soften and shrivel.

Microthyriaceæ.†—G. Arnaud continues his study of this family of microfungi. He maintains that there is frequently a mycelium produced external to the perithecium which creeps on the surface of the leaf of the host-plant and pierces it in places. He describes this mycelium and the manner of attack. Incidentally he states that *Trichothyrium* is simply a *Microthyrium* adapted to parasitism on another superficial fungus, generally *Meliola*. On the various characters Arnaud establishes two new genera, *Hariotula* and *Patouillardiana*.

Development of Yeast.‡—Kendo Saito has experimented with several yeasts on a large number of different culture media in order to test the chemical substances that influence the formation of spores, etc. He gives an historical sketch of similar work done in other groups of fungi. He explains his own methods and gives full details of the culture of each species. He also discusses fully the formation of spores in the genus, their importance in correct diagnosis, and the conditions that further or retard their growth.

Notes on Discomycetes.§—J. Bayliss Elliott records *Orbilia curvatispora*, new to Britain, and found by her in Warwickshire and Hampshire. The ascomata are pale when young, but become pale apricot when older. On pine logs she found another Discomycete, evidently identical with *Sarea pinea* Bon., which she now places in *Belonidium*, and publishes a complete description. Two species of *Ombrophila* were found on alder catkins in December, and accompanying one of them, *Ombrophila alniella*, she discovered a pycnidial form hitherto undescribed. The pycnidium is excipuliform and forms the type of a new genus, *Acleistia alniella*. The spores are simple and colourless, and, when mature, stream out in a gelatinous mass.

Observations on the Oak Oidium.‖—F. W. Neger had declared his opinion that the *Oidium* from *Rubus* might be identical with that on the oak, but by cultures, etc., he has become convinced that they are distinct, though it is possible to cultivate *Oidium Ruborum* on the oak.

* Journ. Agric. Research, vi. (1916) pp. 627–40 (1 fig.). See also Bull. Agric. Intell. Rome, vii. (1916) p. 1711.
† Comptes Rendus, clxiv. (1917) pp. 888–90.
‡ Journ. Coll. Sci. Tokyo, xxxix. (1916) pp. 1–73.
§ Trans. Brit. Mycol. Soc., v. (1917) pp. 417–21 (1 pl.).
‖ Naturwiss. Zeitschr. Forst. Landw., xiii. (1915) pp. 544–50 (2 figs.). See also Bull. Agric. Intell. Rome, viii. (1917) pp. 803–5.

He has also established that the fungus very rarely winters on the oak buds, but the few conidia that survive are sufficient to start again a serious epidemic in the spring. The first shoots of the new growth suffer only slightly, as there are not sufficient conidia to infect them, but the leaves of the second shoots are more seriously affected by wind-borne conidia, which have immensely increased, and the disease is at its height from the middle to the end of July.

Oidium lactis.*—G. Linossier has carried out experiments to test the relationship of *Oidium lactis*, a saprophytic fungus, with a parasite of the human organism known by the same name. He has concluded that though fundamentally the two fungi resemble each other strongly they are not identical, and that therefore bronchial mycosis is not due to infection by the saprophytic *Oidium*. They differ in some morphological points on the various cultures.

British Species of Phomopsis.†—W. B. Grove has revised the genus *Phoma*, and has followed Saccardo and other fungologists in placing a number of species described as *Phoma* under the genus *Phomopsis*. It is distinguished by the form of the pycnidium, which is generally lens-shaped, conical or pustular, but rarely subglobose, and sometimes opening by a slit or irregular orifice. There are also two spore forms, the second form including long filiform curved or arcuate spores somewhat like those of the genus *Phlyctæna*. A descriptive list of these is appended, nearly all of them transferred from the genus *Phoma*. There are two new species.

Uredineæ.‡—G. Gustav has studied the hibernation and spread of cereal rusts in sub-tropical climates, chiefly as concerns the Eastern portion of South America (Uruguay, Argentine, South Brazil), where the rusts appear regularly every year. He finds that *Puccinia triticina* and *P. coronifera* winter by means of their uredospores; fresh infections may be observed all through the winter. This is impossible in the case of *P. Maydis*, and has not been observed in *P. graminis*, and he concludes that these two species pass the winter in another country, and the spores are transmitted every year by air-currents.

A. Trotter § records biological observations on *Ræstelia cancellata*, a rust attacking the pear. This rust has an alternative stage, *Gymnosporangium Sabinæ* on *Juniperus Sabina*. This latter teleutospore form appears from January to April. The teleutospores germinate and produce sporidioles, and it is by the dissemination of the sporidioles that infection of the pear follows. He proved that there is no hibernation of mycelium in the pear, and that reinfection must take place every year.

A number of Uredinaceæ have been determined by W. B. Grove ‖ on

* C.R. Soc. Biol. Paris., lxxx. (1917) pp. 283-6.

† Kew Bull., 1917, pp. 49-73 (2 pls.).

‡ Zeitschr. Pflanzenkr., xxvi. (1916) pp. 329-74. See also Bull. Agric. Intell. Rome, viii. (1917) pp. 160-3.

§ Riv. Pat. Veg., viii. (1916) pp. 67-76. See also Bull. Agric. Intell. Rome, viii. (1917) pp. 161-3.

‖ Kew Bull. No. 10 (1916) pp. 269-72 (5 figs.).

plants from East Africa (Uganda and Nairobi). There is one species of *Uromyces*, *U. Polygalæ*, on the sori of which he found pycnidia of *Darluca filum*; the other species belong to *Puccinia*. Of the six species listed one only had been previously described.

Ed. Fisher * records the results of various infection experiments. He placed the teleutospores of *Thecospora sparsa* from *Arctostaphylos alpina* on new young shoots of *Abies pectinata* and some other conifers. After a time æcidia were observed on the *Abies*; they are very similar to those of other *Thecosporæ*; the spores become orange-coloured.

The writer also inoculated successfully *Pucciniastrum Circeæ* on the same plant, the teleutospores having been collected from *Circæa lutetiana*. Both are cases of new infections.

J. C. Arthur † writes on the orange rusts of *Rubus*. It had been demonstrated by Kunkel that, in the United States, there existed two types of such rusts on *Rubus*: one a long cycle form identical with *Gymnoconia interstitialis*, and the other a short cycle form first named by Schweinitz as *Æcidium nitens*. These forms are alike morphologically; there is no difference between the æcidium of the one and the teleutospore sorus of the other, except in the process of spore-germination. Arthur accepts Kunkel's decision, and proposes a new generic name, *Kunkelia*, for the new genus, diagnosed as being composed of sub-cuticular pycnidia and sub-epidermal teleutospore sori. The teleutospores are catenulate, globoid, or, in some cases, elongated, one-celled, the epispore colourless or pale and verrucose. There are no paraphyses or peridium. A list is given of host-plants, but it is necessary to germinate the spores in order to determine the genus of the rust present. Arthur suggests with some assurance that the rose *Cæoma* of Northern California may prove to be a species of *Kunkelia*.

A study of North American species of *Puccinia* on *Carex* has been made by Frank D. Kern.‡ Telia and teliospores do not afford good diagnostic characters, but the uredospores are more distinctive and of more value in classification, and have been chiefly used in the synoptic tables drawn up by the author. The æcidia are to be found on a wide variety of hosts; in only one case is the host monocotyledonous. Kern describes nineteen species, a few of them being new to science.

G. G. Hedgcock and N. Rex Hunt § publish some new species of *Peridermium*:—*P. Ipomeæ* on *Pinus echinata*, etc., the æcidial form of *Coleosporium Ipomeæ*; *P. terebinthaceæ*, also on several species of *Pinus*; and *P. Helianthi*, which has been collected on *Pinus virginiana*. Two other species, *P. fragile* and *P. minutum*, have not been associated with their *Coleosporium* stages.

M. Savelli ‖ has published a list of Uredineæ from Tuscany, many of them new to that province. He has added not only new localities but new hosts for a number of species. Biological observations are given as well as numerous morphological and bibliographical notes.

* Centralbl. Bakt., xlvi. (1916) pp. 333–4. See also Bull. Agric. Intell. Rome, viii. (1917) pp. 660–1.

† Bot. Gaz., lxii. (1917) pp. 501–15.

‡ Mycologia, ix. (1917) pp. 205–38.

§ Mycologia, ix. (1917) pp. 239–42.

‖ Nuovo Giorn. Bot. Ital., xxiii. (1916) pp. 235–59.

British Thelephoraceæ.*—E. M. Wakefield continues her work on resupinate fungi, dealing mainly with the genus *Hypochnus*, in which are included only species with coloured warted spores, and to which are referred all species hitherto classified under *Lomentella*, a genus of later date. There is one new species described, *Hypochnus cyaneus*, which varies in colour from "deep dull violaceous blue" through "Eton blue" to "glaucous green." It was found at Kew on wet coniferous logs. Another new fungus, *Corticium coprophilum*, is also recorded and described; it grew on old horse-dung in a flower-bed; it is distinguished by the habitat and by the minute globose spores.

Sparassis radicata sp. n.†—James R. Weir has described this new member of the genus; it is distinguished by its thin lobes and by an unusually large perennial rootstalk of the nature of a sclerotium, from which new sporophores are developed from year to year. He also discusses the systematic position of the genus, which he thinks should be placed in the family Thelephoraceæ.

The new fungus is generally found growing at the base of coniferous trees; it is 12–22 cm. broad and 10–16 cm. high, dilated above and whitish, becoming creamy yellow with age. The most important feature is its parasitism on the roots of conifers to which the long rootstalk is attached. The mycelium attacks the bast of the roots, later the wood, producing a yellow or brown carbonizing rot. Up to date only four trees, all conifers, have been found to have succumbed to the action of the fungus.

Contribution to the Study of Coprinus.‡—A. Sartory publishes microscopic details of a series of *Coprini*, with especial reference to the form, size and exact coloration of the spores, the form of the cells composing the gills, and the form and disposition of the gills themselves. The cystidia when present are also described.

Critical Notes on Coprinus, etc.§—A. H. E. Buller publishes some results of his long study of the genus *Coprinus*. He gives seven points in connexion with the production and liberation of spores that are peculiar to *Coprinus*, and that are all inter-related; they consist of the structure of the gills, the position of the maturing spores from below upwards, and auto-digestion of the gills. The author then proceeds to discuss the systematic position of *Psathyra urticæcola*, which he judges to be a true *Coprinus*. *Coprinus plicatilis* is considered and found to be also a true *Coprinus*, though it has lost one of the *Coprinus* characters, namely, auto-digestion. *Psathyrella disseminata* has recently been transferred by Lange to *Coprinus*, but Buller finds that it lacks all the decisive *Coprinus* characters, and considers that there is no good reason for changing its systematic position.

* Trans. Brit. Mycol. Soc., v. (1917) pp. 474–81.
† Phytopathology, vii. (1917) pp. 166–77 (5 figs.).
‡ C.R. Soc. Biol. Paris, lxxx. (1917) pp. 347–8.
§ Trans. Brit. Mycol. Soc., v. (1917) pp. 482–9.

Edibility of Fungi for Rodents.*—Somerville Hastings has made observations on this subject for a number of years. The notes refer mainly to squirrels and rabbits, and to fungi eaten in the late summer and early autumn ; but it is not until frosts begin, and other foods become somewhat scarce, that they are consumed to any large extent. Hastings gives many data, both of fungi found to be nibbled, and of experiments by feeding rabbits with various fungi. Those that were more or less palatable are indicated ; species poisonous to man, such as *Amanita muscaria* and *Russula emetica*, were eaten, the former on six occasions, the latter once. One fact he noticed was the immediate sureness with which the animal either ate or rejected fungi offered to it ; selection was made almost certainly by the sense of smell, and in no instance did the creature change its mind. The paper is well illustrated by photographs.

Montana Forest-tree Fungi.†—James R. Weir has for some time been collecting these fungi, and in the present paper he gives a list of the Polyporaceæ, a very long series, though he does not think that it is yet complete. Probably some have not been found, and of those collected a number have not been identified.

"Owing to the wide extension of the State of Montana to the east and west of the Continental Divide, the fungous flora includes many species of the central as well as of the Pacific Coast States. The heavily-wooded section in the north-western part has practically the same fungous flora as British Columbia." The genera dealt with are *Merulius*, *Polyporus*, *Poria*, *Polystictus*, *Fomes*, *Trametes*, *Dædalea*, *Lenzites*, and *Favolus*.

Notes on Australian Fungi.‡—J. B. Cleland and E. Cheel have taken up the study of Australian fungi, especially of the larger Basidiomycetes. They begin with a fairly long list of *Coprini*, one of which, *C. sclerotianus*, is a new species ; the specimens were developed from sclerotia collected under cow-dung Other genera are also dealt with—*Thelephora*, *Stereum*, *Clavaria*, etc. A number of species were identified for the writers by C. G. Lloyd.

Nutritive Value of Edible Fungi.§—In a paper on this subject it is concluded that the available protein in fungi is less than has been frequently estimated, and mushrooms can in no case be regarded as flesh-forming foods, such as meat. The total nutritive value of the mushroom which is richest in proteid substances is no higher than that of cabbage or potatoes, and really inferior to the latter on account of the poorer carbohydrate content. The value of mushrooms is more one of flavouring, by which other food is rendered more palatable.

New Japanese Fungi.‖—Tyôzabrîro Tanaka has begun a series of notes and translations of newly discovered and described fungi from

* Trans. Brit. Mycol. Soc., v. (1917) pp. 364–78 (12 figs.).
† Mycologia, ix. (1917) pp. 129–37 (1 pl.).
‡ Proc. Linn. New South Wales, xli. (1916) pp. 853–70.
§ Journ. Board Agric., xxiv. (1917) pp. 416–9.
‖ Mycologia, ix. (1917) pp. 167–72.

Japan. The species described so far are all microfungi and are parasites on trees or herbs.

In a later paper* he gives a second series which includes two species of *Phytophthora*, one on leaves and flower stalks of *Allium fistulosum*, and the other on a *Solanum*. There are also several Pyrenomycetes described. All are new species.

New or Rare Fungi.†—A. Lorrain Smith and J. Ramsbottom publish a list, with descriptions and notes, of the microfungi that have been determined during the year as new, or new to Britain. Most of the new finds are leaf-fungi and belong to the Ascomycetes or to the Fungi Imperfecti.

A similar descriptive list‡ dealing mainly with the larger fleshy fungi is supplied by Carleton Rea. Three species are new to science: *Marasmius pruinatus*, with a densely pruinose pileus and stem; *Cortinarius fusco-tinctus*, in which the pale ochraceous pileus and stem become reddish, then blackish or fuscous, when touched; and *Lasiobolus macrotrichus*, distinguished by the very long hairs on the ascoma.

Mycological Notes.§—These, issued by C. G. Lloyd, contain illustrations and observations on various rare or unusual forms of the larger fungi received by him from all quarters of the globe. Species of *Polyporus*, *Guepinia*, *Favolus*, *Cantharellus*, etc., are passed in review. There is an extended note on *Lentinus Tuber-regium*, which is developed from a large sclerotium and has been renamed several times.

Two other pamphlets, also by Lloyd,‖ have been received. They deal in a similar way with recently collected material. One deals wholly with species of *Radulum*, several of them, such as *R. Balouii*, evidently new species. The genus comprises resupinate fungi the hymenium of which is studded with "blunt tubercular teeth." The second "letter" pamphlet discusses "some lost Xylarias." Some of these exist in figures only such as *Xylaria Geoglossun* figured by Schweinitz, but which is probably a *Geoglossum*.

British Mycology.¶—An account is published of the annual foray of fungologists in the autumn of last year. The meeting of the British Mycological Society was held at Lyndhurst, and various excursions were made in the New Forest. Over five hundred species of fungi and fifteen mycetozoa were collected during the week. Three species of *Hypochnus* new to Britain, one of them new to science, were collected. A full list of the fungi obtained is appended; many of them had not previously been found in the New Forest.

The presidential address was given by E. W. Swanton (in absence), who dealt with "Education in Mycology." He urged the great economic importance of the study, and outlined the position of mycological teach-

* Mycologia, ix. (1917) pp. 249–53.
† Trans. Brit. Mycol. Soc., v. (1917) pp. 422–33.
‡ Trans. Brit. Mycol. Soc., v. (1917) pp. 434–40 (1 pl.).
§ Cincinnati, Ohio, No. 47 (1917) pp. 653–68 (figs.).
‖ Cincinnati, Ohio (1917) 12 pp. (figs.); and Letter No. 64, 4 pp. (figs.).
¶ Trans. Brit. Mycol. Soc., v. (1917) pp. 351–64, 381–407.

ing facilities in our country and in the various colonies; finally, he indicated some of the ways in which that teaching could be improved here and our knowledge extended. A contrast is also drawn between what we have achieved and mycological education in other countries.

Economic Mycology.*—W. N. Cheesman has treated this subject in his presidential address to the members of the Yorkshire Naturalists' Union. He gives an historical and general sketch of fungi and describes the properties of certain fungi that makes them valuable as food. He discusses the plans for making such food more generally available and acceptable, emphasizing especially the need of education.

The other side of the question is then dealt with: the fungi that cause disease to the organisms and immense material loss, the world's annual loss being estimated to exceed 300,000,000*l*. Several of the more prevalent pests are discussed along with questions of immunity and remedial measures. Finally, the study of fungi is strongly recommended.

Notes on Fungus Development.†—M. E. M. Johnson gives the results of observations on some minute fungi which appeared on blocks of *Panus stypticus* which were being experimented with in the laboratory. In *Botrytis pyramidalis* she found a frequent change of colour; the tufts of the fungus growing in the light became a deep blue-green, those in the shade remained white; she also noted that when mature the conidiophore fell with the conidia attached.

Another fungus, *Sphæronæma cornutum*, also appeared on the wood on which the *Panus* grew, and it was found to be constantly associated with *Haplographium olivaceum*, the latter fungus even appearing to spring from the pycnidium of the *Sphæronema*. The constant association of the two fungi suggested some connexion between them, as stages in the life cycle possibly.

Cytology of Fungus Reproduction.‡—J. Ramsbottom has reviewed the work done on this subject during the year. The papers he quotes deal with members of the Phycomycetes, Ascomycetes, Uredineæ, Basidiomycetes, and Hyphomycetes. Important research has been carried out in these different groups, more especially in the Basidiomycetes, and much of it is intimately related with systematic work.

Fungus Folk-lore.§—E. W. Swanton contributes notes on this subject:—*Daldinia concentrica* has been used as a safeguard against cramp; puff-balls have been frequently used as styptics; *Fomes pomaceus* has a reputation as a poultice for a swollen face; razor-strops were quite frequently made from *Polyporus betulinus*, and that fungus was also used as tinder by Surrey and Sussex villagers.

* Naturalist, 1917, pp. 185–200.
† Trans. Brit. Mycol. Soc., v. (1917) pp. 414–6 (1 pl.).
‡ Trans. Brit. Mycol. Soc., v. (1917) pp. 441–61.
§ Trans. Brit. Mycol. Soc., v. (1917) pp. 408–9.

Witches-brooms on Hickory Trees.*—F. C. Stewart describes these brooms as consisting of compact clusters of short upright branches. They measure up to two-thirds of a metre when bare, and are larger when in foliage. The writer has found the fungus *Microstroma Juglandis* on the leaves of the brooms, and he concludes that their presence is due to that fungus.

Fungi Toxic to Bees.†—Göte Turesson has been studying the cause of bee paralysis, and has come to the conclusion that it is due to moulds. These infest hives that are poorly constructed, and the bees wintering in them are very liable to the disease. The author has proved his contention by culture methods, securing his fungi from the intestines of dead bees and mixing the material with honey. The moulds used were *Penicillium* sp., *P. stoloniferum*, *P. conditaneum*, *Mucor mucedo*, and *Cladosporium herbarum*. There was an equal degree of toxicity in *Penicillium* sp., *P. stoloniferum*, and *Cladosporium herbarum* ; *Penicillium conditaneum* was the most virulent, and next in degree *Mucor mucedo*.

The harm to the bees is not caused by parasitism, but by the toxic substances of the hyphæ, phenol, or phenolic acids. The action is at first stimulating, and later comes paralysis of the nerves and the death of the bees. Bees fed with pure honey were used in control experiments which confirmed the finding from the mould material.

Diseases of Plants.‡—B. A. Rudolph describes disease spots on cherry-leaves which he has diagnosed as due to *Alternaria Citri* var. *Cerasi*. This is a wound parasite and may produce spots on various plants. Many culture experiments were undertaken and are fully described.

H. T. Güssow § publishes some notes on the pathogenic action of *Rhizoctonia* on potato. He notes the absence of fine rootlets in plants that have been attacked, and considers that the destruction of these rootlets is the main injurious action of the fungus.

A report of the Horticultural Branch of the Board of Agriculture ‖ deals with the prevalence of various serious diseases. Gooseberry mildew (American) has declined, the favourable result being due to spraying methods which have been perfected. Another method of counteracting the disease is to tip the tender shoots which are affected ; lime-sulphur and Bordeaux washes have also proved effective. Wart disease of potatoes has spread, but energetic means are being taken to deal with the trouble. Immune varieties of potato are strongly recommended, and seed from infected soil should not be used, as the soil attached to the healthy potato may carry the disease. Corky scab of potato (*Spongospora subterranea*) has also been frequently notified. It is found that weather conditions, such as a wet season, greatly increase the disease.

* Phytopathology, vii. (1917) pp. 185–7 (1 fig.).
† Svensk. Bot. Tidskr., xi. (1917), pp. 16–38.
‡ Phytopathology, vii. (1917) pp. 188–97 (3 figs.).
§ Phytopathology, vii. (1917) pp. 209–13 (1 fig.).
‖ Journ. Board Agric., xxiv. (1917) pp. 146–52.

J. B. Rorer * gives some account of "pink disease" of *Cacao* due to *Corticium salmonicolor*, which covers the branches on the lower side with its incrustations. It is not a disease that reaches any serious proportions, but if the larger branches are reached much harm may be done. Bordeaux mixture and other fungicides are recommended.

Some diseases of forage plants in South Africa † have been investigated by Van der Bigl: on *Chloris* he records *Tolyposporium Chloridis* and *Epichloe* sp.; on *Sporobolus* he finds *Helminthosporium crustaceum*. *Paspalum* is seriously attacked by the ergot *Claviceps Paspali*; and growers are warned against disseminating Ustilagineæ by feeding cattle with diseased straw. All cereals so diseased should be burned.

Pole Evans ‡ records a disease caused by *Sorosporium Simii* sp. n. (Ustilaginales) on *Sorghum halepense*. As the host is perennial Evans argues that the inflorescence may be infected by the fungus; usually it is the seedling that is first attacked.

T. Westerdijk § has reported a new disease of tobacco in Sumatra due to a fungus identified as *Sclerotium Rolfsii*. The disease shows itself by the withering of the leaves, a white felt of mycelium on the roots, and by the brown sclerotia some few milimetres wide. The same fungus causes disease on *Hibiscus* and on *Canavalia* in Java. Methods of dealing with the trouble are discussed.

A disease attacking the shoots and fruit of fig-trees in England has been diagnosed by W. B. Brierley ‖ as due to the fungus *Botrytis cinerea*. The fruit is usually entered by the pore and soon is completely destroyed. When a shoot is inoculated the mycelium spreads on all sides and kills the shoots. All diseased portions should be removed.

James Johnson ¶ has published a list of plants that are liable to attack of the parasite *Thielavia basicola*. Many of these were ascertained by infection experiments. There is a very long list, but the families that suffer most are the Leguminosæ, Solanaceæ, and Cucurbitaceæ. There are no specialized races. Infection occurs mainly or only on the roots or on the base of the stem just at, or below, the soil.

B. Peyronel ** has found on the roots of *Lupinus albus* a parasitic fungus which spreads in reddish-brown patches, destroying the very young plants. The disease is caused by *Chalaropsis thielavioides*, gen. et sp. n. The fungus has an almost colourless branching mycelium which gives rise to macroconidia (or chlamydospores) and to microconidia. The macroconidia are brown with very thick walls, and look like black powder in the mass; the microconidia are colourless and are

* Bull. Dept. Agric. Trinidad and Tobago, xv. (1916) pp. 86–9 (1 pl.). See also Bull. Agric. Intell. Rome, vii. (1916) pp. 1548–9.

† Agric. Journ. and Small Holder, South Africa, iv. (1916) pp. 37–9 (6 figs.). See also Bull. Agric. Intell. Rome, vii. (1916) pp. 1854–5.

‡ South African Journ. Sci., xii. (1916) pp. 542–3. See also Bull. Agric. Intell. Rome, vii. (1916) p. 1855.

§ Med. Delim. Proefst., x. (1916) pp. 30–40 (2 pls.). See also Bull. Agric. Intell. Rome, viii. (1917) p. 309.

‖ Kew Bull., No. 9 (1916) pp. 225–9 (2 pls.).

¶ Journ. Agric. Research, Washington, vii. (1916) pp. 289–300 (2 pls.). See also Bull. Agric. Intell. Rome. viii. (1917) pp. 476–9.

** Le Staz. Sperim. Ital. Modena, xlix. (1916) pp. 583–96 (5 figs.). See also Bull. Agric. Intell. Rome, viii. (1917) pp. 479–80.

borne in chains on conidiophores. The disease is very easily cultivated on artificial media from either type of spore.

P. J. O'Gara * describes a new leaf-spot disease on *Polygonum Persicaria* due to a species of *Septoria* (*S. Persicariæ* sp. n.). The spots on which the pycnidia are borne are less than 1 cm. in diameter, grey or brown with a narrow limiting purple line; the spores are filiform, long and narrow.

T. H. Watson † has described as diseases of the spruce (*Picea excelsa*) in Scotland; *Trametes radiciperda*, a root fungus very common; *Chrysomyxa Abietis*, which is confined to old mature trees; and *Lophodermium macrosporum*, which attacks the needles and has caused the death of many trees. *Cucurbitaria Piceæ* was also observed on the buds of spruces seventy years old.

A. Lendner ‡ describes two parasitic diseases: *Pestalozzia Briardi*, which was found at the base of a vine-shoot inducing cancerous formations; and *Lophionema Chodati*, which occurs as small black pustules on the cones of *Pinus sylvestris*.

Storage Rots of Economic Aroids.§—The corms and tubers of various Aroids (*Colocasia*, *Alocasia*, *Xanthosoma*) are used for food in America, and in storage are largely liable to rot. L. L. Harter has examined these rots, and gives an account of the fungi mainly responsible. They are:—Java black-rot, due to different species of *Diplodia*; powdery grey-rot, caused by *Fusarium Solani*; Sclerotium-rot, by *Sclerotium Rolfsii*; and a soft-rot caused by *Bacillus cartovorus*. The writer describes the attack and the effect of these diseases, and gives suggestions as to prevention and cure.

Research on Plant Diseases.—E. Gaumann ‖ has conducted a research on the distribution of *Peronospora parasitica*, a parasite of cruciferous plants, in which specialization is carried to a very high degree. Infection experiments on various hosts within the family were carried out, and careful morphological observations were made on the variations in conidia, conidiophores, and oospores. The author has proved a very high degree of specialization.

O. A. Pratt ¶ has experimented with disease-free potato tubers on virgin soil in Idaho. He found that the crops were by no means free from disease. Several species of fungi—*Fusarium*, *Rhizoctonia*, and scab due to *Actinomyces*, were of common occurrence. A smaller percentage of disease occurs, however, on land previously sown with barley and lucerne.

* Mycologia, ix. (1917) p. 248 (1 pl.)

† Trans. R. Scott. Arbor. Soc., xxxi. (1917) pp. 72–3.

‡ Bull. Soc. Bot. Genève, viii. (1917) pp. 181–5. See also Bull. Agric. Intell. Rome, viii. (1917) pp. 809–10.

§ Journ. Agric. Research, Washington, vi. (1916) pp. 549–71 (4 pls.). See also Bull. Agric. Intell. Rome, vii. (1916) pp. 1852–4.

‖ Centralbl. Bakt., xlv. (1916) pp. 575–7. See also Bull. Agric. Intell. Rome, vii. (1916) p. 1851.

¶ Journ. Agric. Research, Washington, vi. (1916) pp. 573–5. See also Bull. Agric. Intell. Rome, vii. (1916) pp. 1851–2.

P. Kropoulos * has investigated seedling blight, with special reference to *Brassica* plants. He finds a fungus which exactly corresponds with *Moniliopsis Aderholdii* in the young plants. If these are attacked before the first leaves are formed death ensues ; but if the leaves have already developed the plant may recover.

A. A. L. Rutgers † has investigated a *Peronospora* disease of maize, known in Java as "Omo Lyer." Plants attacked at an early stage die off ; if the infection takes place at a late stage the leaves become striped with yellow ; with some, ripe seeds may be produced. The host-plants when young may be infected by conidia.

A. J. Lobik ‡ publishes a study of the effect of various diseases on clover. He includes four parasites in his table of calculations :— *Phyllachora Trifolii*, *Erysiphe Polygoni*, *Glœosporum caulivorum*, and *Uromyces Trifolii*. Thus, according to approximate calculations, the average crop of clover should be 36 cwt. per acre, but if attacked by *Glœosporium* it is only 21·4 to 23 cwt. per acre. In the case of the rust, *Uromyces Trifolii*, the production is higher than in healthy plants. The attacked plants were actually taller, more bushy, and had more abundant flower-heads.

Rubber Diseases.—J. F. Dastur § reports on *Phytophthora* sp. as the cause of Black-thread Disease of *Hevea brasiliensis* in Burma, which causes a very great loss of rubber. The fungus grows mainly on the fruit, but passes to the stem to the wounds left on tapping for rubber. Light and air are essential agents in checking the disease.

J. G. C. Vriens ‖ has described the action of *Stilbella Heveæ* and of *Ustulina zonata* on rubber-trees. The mycelium of *Stilbella* spreads over the young shoots and leaves, which soon lose their colour and die. *Ustulina* attacks the wood through wounds probably caused by insects. The destruction of infected material is recommended in both cases, and care should be exercised not to leave dead wood about that would harbour insects.

Tuber-rot in Potatoes.¶—O. A. Pratt finds that *Fusarium radicicola* gives rise to two types of rot :—1. Dry- or black-rot, characterized by the blackening of the tissues, ensues when the fungus enters the tuber by the stem-end or point of the branch where the swelling of the tuber begins, by the lenticals, and by the eyes. In these different infections the fungus reaches somewhat different tissues, but in all cases the infected tubers show a sunken brownish-black region. 2. Soft-rot, when the

* Centralbl. Bakt., xlv. (1916) pp. 244–56. See also Bull. Agric. Intell. Rome, vii. (1916) pp. 1855–6.

† Med. Lab. Plantenz., No. 22 (1916) 30 pp. (7 pls.). See also Bull. Agric. Intell. Rome, viii. (1917) pp. 305–6.

‡ Bull. Phytop. Stat. Bot. Gard. Petrograd, 1915, pp. 115–30. See also Bull. Agric. Intell. Rome, viii. (1917) pp. 307–8.

§ Dept. Agric. Burma, Bull. No. 14 (1916) pp. 1–4 (1 pl.). See also Bull. Agric. Intell. Rome, vii. (1916) pp. 1547–8.

‖ Med. Adors. No. 5, Médan (1916) pp. 66–8. See also Bull. Agric. Intell. Rome, vii. (1916) pp. 1712–13.

¶ Journ. Agric. Research, Washington, vi. (1916) pp. 297–309. See also Bull. Agric. Intell. Rome, vii. (1916) pp. 1546–7.

fungus penetrates the tuber at the point of its formation and the infection spreads inwards, the diseased parts becoming brown ; this latter disease is probably due to the association of *F. oxysporum*.

Problems of Plant Pathology.*—F. L. Stevens writes on this subject with regard to the fungi that form diseases. He quotes a previous author as to the conception of three categories of plant diseases :—1. Those in which the parasites kill the living cells. 2. Those in which it lives in association with them, feeding on their products. 3. Those in which the parasites invade the vessels and live in the sap. Stevens has divided parasites into a more detailed series, which he has shortly summarized as :—1. The parasite living in the sap or in parts devoid of protoplasm. 2. The parasite drawing its nutriment from living cells. 3. The parasite living in cells that it has just killed. Stevens points out the various aspects of plant pathology that are imperfectly understood and that require to be studied.

Lichens.

(By A. Lorrain Smith, F.L.S.)

African Lichens.†—Carlo Zanfrogini has published a descriptive list of lichens collected by Guido Paoli in Somali Land. Very full notes of structural and other peculiarities are given. Eighteen species or varieties have been thus fully described ; none of them are new nor peculiarly African. Graphidineæ are well represented.

Chænotheca melanophæa var. flavocitrina.‡—R. Paulson, who discovered this new variety, found it covering large areas of the trunks of various trees in Bricket Wood, Herts. It develops first under the bark, and later emerges on the surface where the somewhat long-stalked fruits are formed. The presence of salazinic acid—as is the species—is proved by the purple reaction with potash. The host-cells in contact with the lichen are mainly affected with the stain.

Rate of Growth and Spreading (Ecesis) in Lichens.§—Bruce Fink gives us a series of observations made over a period of eight years as to the rate of growth of lichen thalli, and also as to period of time required to re-establish a lichen on areas from which the plants had been removed. Numerous results are given as to the rate of growth, most of them about 1 cm. per year, or somewhat under. The greatest rate seems to have been recorded for a plant of *Peltigera canina* growing on "a mossy rock along a brook in a low moist wood, well-shaded." A plant,

* Bot. Mag., lxiii. (1917) pp. 297–306.
† Nuova Notarisia, xxviii. (1917) pp. 145–75.
‡ Journ. Bot., lv. (1917) pp. 197–8.
§ Mycologia, ix. (1917) pp. 138–58.

measuring 10 by 14 cm., was deprived of several large apothecia. The lobes all pointed in the same direction, and the plant increased 1·75 cm. in one year. Two other plants, deprived of their lobes, regenerated and increased from 2 and 5 cm. respectively to 3·5 and 6 cm. No other measurements are quite so high as these, though a plant of *Parmelia caperata* (sterile), measuring from 1·2 cm. across, reached in eight years a dimension of 10 by 13 cm. Other plants of the same species gave much slower rates of increase. A section of railing was marked bearing minute scattered squamules of *Cladonia pityrea*. After two years the squamules had attained normal size and podetia were formed 2 to 4 mm. long.

Several areas of *Verrucaria muralis* were marked and after ten months were again measured; the largest plants, measuring 2·12 by 2·4 cm. across, had somewhat altered in dimensions and gave the measurements 2·2 by 3 cm.

A quadrate of limestone rock was scraped bare of moss and of *Leptogium lacerum*, except for bits of the moss and particles of the lichen which adhered to the rock, especially in depressions of the surface. After four years the moss was colonizing many small areas, and many of the patches bore specimens of the lichen 2 to 10 mm. across. Very little change occurred during the next four years.

The results as far as possible are summarized and opinions hazarded as to methods of migration to denuded areas. The general rate of increase is given for a varied series of lichens. Some crustose species become established and produce thalli and apothecia in two to eight years. Foliose lichens increase in diameter from 0·3 to 3·5 cm. per year (the latter observation not verified in the text). So far as external appearance goes apothecia are produced in one to eight years; it is concluded that these require four to eight years to attain maturity in their natural habitats.

Mycetozoa.

(By A. Lorrain Smith, F.L.S.)

Observations on Badhamia utricularis.*—W. T. Elliott has been experimenting with the plasmodium of *Badhamia* and its food supply. He holds the view that *Badhamia* and other mycetozoa do not live solely on bacteria but also on fungi, that they probably assimilate the fungus mycelium so abundant in the dead wood they occupy. He tested the plasmodium on a series of fleshy fungi, and he has observed the partial disappearance of the fungus, and the changes in the plasmodium according to the colour of the fungus on which it was feeding. Elliott looks on mycetozoa as parasites more animal than vegetable; they assimilate or consume the tissue of the living fungus, withdrawing nutrient substance, including proteids, from the host.

* Trans. Brit. Mycol. Soc., v. (1917) pp. 410–13.

Schizophyta.

Schizomycetes.

Spirochæta morsus muris.*—K. Futaki, I. Takaki, T. Taniguchi and S. Osumi report the discovery of a new species of spirochæte in the blood, skin and lymph glands of four patients suffering from rat-bite fever. The spirochæte is smaller than *S. recurrentis*, but larger than *S. pallida*; it is very motile, stains well, and shows a single flagellum at each end, and does not possess an undulating membrane. The curves are regular and range from two to nineteen, generally three or four. The larger forms are found in the tissues, the smaller in the blood. This spirochæte is found in the blood of 3 p.c. of the house-rats in Japan, and is considered by the author as the cause of Japanese rat-bite fever. Mice are best for experimental inoculations, white rats next, while guinea-pigs and monkeys often fail to become infected. The type of fever produced in monkeys is not typical of the human condition. Salvarsan cleared the blood of the monkeys in fourteen days, but relapses then occurred.

Streptothrix in Broncho-pneumonia of Rats.†—Ruth Tunnicliff has examined a series of sixty white rats which showed evidence of acute or chronic broncho-pneumonia, and in fifty-six a long, fine, straight, wavy filamentous organism was found. This organism was not observed in a series of twenty-four normal rats. It was Gram-negative, non-acid-fast, and stained with difficulty, the best results being obtained with Giemsa and carbol-fuchsin, and also by Levaditi's method for tissues. The organism was isolated in pure growth on thirteen occasions, the greatest success being obtained when the lesions were acute and when other bacteria were present. The production of anti-bodies in infected rats was demonstrated by the presence of specific opsonins and agglutinins. The organism was pathogenic to white rats, but not to rabbits or guinea-pigs, and but slightly to monkeys. As white rats are not known to cause rat-bite fever, twenty-eight wild rats were examined, and the same organisms and lesions in the lungs were found in one of them as in the white rats. The organism is probably the same as that described by Schottmüller and others as *Streptothrix muris ratti*.

Serotherapy in Gas Gangrene.‡—Wm. Weinberg and P. Séguin have given a mixed antitoxic serum (anti-perfringens, anti-V. septique, and anti-œdematiens) in cases of gas gangrene with apparently beneficial results. Rapid local and general amelioration of symptoms was observed in most cases. They claim that the serum not only neutralizes the toxin circulating in the organism and arrests the septicæmia, but also favours the local defensive mechanism against infection and stimulates phagocytic

* Journ. Exper. Med., xxv. (1917) pp. 33–44.
† Journ. Infect. Diseases, xix. (1916) pp. 767–71.
‡ Comptes Rendus, clxv. (1917) pp. 199–201.

activity. The initial dose recommended is 60–90 c.cm. of an equal mixture of the three sera. The serum may be given intravenously or subcutaneously, the former method being especially recommended. If there be time to demonstrate which organism plays the principal rôle in infection, the dose of the serum corresponding to the particular anaerobe may be augmented with advantage.

Ropy Bread.*—J. M. Beattie and F. C. Lewis have carried out a series of observations as to the cause of the condition known as "ropincss" in bread. The work was originated some years ago in the University of Liverpool, under the direction of the late Sir Rubert Boyce. The causal organism appears to be a member of the *mesentericus* group of organisms, and has been described by Vogel as *Bacillus viscosus panis*. The bacillus is Gram-positive, spore-bearing, and aerobic. When grown on agar the appearance of an early colony is characteristic. It looks like a small drop of thick, transparent, colourless oil, and when touched with a needle is shown to be extremely viscid. If an attempt be made to remove the colony, it will be found that the growth follows the needle and can be drawn upwards, if handled gently, until a strand, one or two inches in length, reaches from the agar to the end of the needle. It is therefore very difficult to detach a portion of the colony. As the colony develops, the clear oil-like character disappears, and a ground-glass opacity is assumed, giving rise later to a dry, wrinkled, typical mesenteric appearance. But the viscosity of the growth is seldom entirely lost, the fresh growing edges invariably showing this characteristic. The organism is non-motile, and forms, in pepton water, a thick, transparent mucilaginous film, very different from the "greyish-white film, which is not broken up by shaking," of *B. mesentericus vulgatis*. If a "ropy" loaf of bread be cut or broken, small glistening masses may be found. These are colonies of the "rope" organism, and the silken strands which may be seen when portions of the bread are drawn gently apart are, in fact, only the viscid colony stretching from crumb to crumb. When the growth in the loaf is well advanced, then the whole mass may become viscid.

The causal organism, *B. viscosus panis*, is present naturally in the husk of the grain, and the infection is more likely to occur where the flour used contains a greater proportion of husk. There is no doubt that the development of the organism in the bread is greatly favoured by moisture and heat, conditions which would be established by storage, after baking, without proper ventilation. The conditions should be eliminated by using proper methods and standards in the production of flour.

Morphological Studies in the Life-histories of Bacteria.†—E. C. Hort endeavours to show in this communication that simple binary fission is not the only method of reproduction amongst bacteria, and that only a fraction of what appears to be a highly complex life-cycle can be studied by cultivation in, or on, synthetic media. In his experiments organisms

* Lancet, cxciii. (1917) pp. 211–2.

† Proc. Royal Soc., lxxxix. (1917) pp. 468–80 (5 pls.).

of the typhoid-dysentery group were used principally, and all possible sources of contamination were rigorously excluded. By using broth + 20 to phenolphthalein, and by sub-culture from this to agar or to MacConkey's medium, thence back again to ordinary broth + 10 to phenolphthalein, a great increase in the size of the organisms is obtained, but the bacilli still give the classical cultural, fermentative and serological reactions.

In all the broth cultures studied, reproduction by simple binary fission was still the predominant feature, and in studying the "aberrant" types of reproduction of single living organisms on the warm-stage on solid media, such as gelatin-agar, ordinary binary transverse fission was found to hold the field mainly, though not absolutely to the exclusion of other forms of reproduction. Reproduction by gemmation occurs freely, in conjunction with ordinary binary fission, only so long as growth proceeds in the thin layer of broth on the cover-slip, and largely comes to an end when colonies are beginning to form on the solid medium. Some of the buds observed were very minute, and when examined by the dark-ground illumination method were found to be minute bacilli undergoing binary fission. Not unfrequently these appear as coccoid bodies if binary fission has not begun. The presence of these minute forms is probably the explanation of the apparent filterability through Chamberland filters of such relatively large organisms as *Bacillus bronchisepticus*, and is perhaps responsible for the general view that even well-made Berkefeld filters are not suitable for bacteriological work.

Bacteriology in Plant Pathology.*—F. L. Stevens gives an interesting account of recent advances in the study of plant pathology. "It appears that the bacteria involved in plant disease are pre-eminently of the genera *Pseudomonas* and *Bacillus*. The Cocci, Bacteria and Spirilli, so prominent in animal pathology, sink to a very minor position." Some of the more important organisms are included in the following list:—

Bacillus amyloverus (host, Pomes), the cause of the pome blight, is widespread and the cause of immense pecuniary loss.

Pseudomonas radiciclea (host, Legumes) occupies the anomalous position of being a beneficial disease.

P. solanacearum (host, *Solanaceæ*) is very wide-spread and destructive, as are also *P. camprestris* (host, Crucifers) and *B. tracheiphilus* (host, Curcurbs). *B. carotovorus* is the cause of soft rot of parenchyma on many hosts and the loss of much produce during storage.

The bacterial leaf-galls of the *Rubiaceæ*, originally described by Zimmermann, are of particular interest as possibly cases of symbiosis rather than parasitism.

P. tumefaciens, the cause of crown-gall on numerous hosts, has been shown to furnish an example of an unsuspected type of plant disease, in many respects analogous to human cancer.

B. avenæ with *P. avenæ* (host, Oats) present an unique case of symbiosis, in that the latter organism is, according to the work of Manns, much more productive of disease when accompanied by the former organism.

* Trans. Amer. Micr. Soc., xxxvi. (1917) pp. 1–12 (1 chart).

B. coli as the cause of a very destructive bud-rot of the cocoanut is especially interesting. One is loath to accept the conclusion, but the work upon which it is based is well done. The experimental evidence is that the bud-rot organism is in all ways indistinguishable from animal *B. coli*, and that *B. coli* from animals will cause the typical rot.

P. citri is one of the latest to attract attention as the cause of the very serious *Citrus* canker which bids fair to make destructive inroads upon fruit culture in the Gulf States.

A group of diseases of distinct type, the "wilts" are found to be largely bacterial and are due to a plugging or embolism brought about by the growth of bacteria within the vessels of the plant. Infection has been shown to occur in a variety of ways, notably through wounds which break down the outer protective plant coverings, or through natural openings such as stomata, water-pores or nectaries. Apart from the important rôle played by insects in the transmission of plant diseases, surface soil water is in some cases responsible for extensive distribution of the parasite. Continued growth and multiplication of parasitic bacteria in the fallen plant parts, or even in the manure pile, offer an additional explanation of disease dispersal in some instances. In other cases it has been demonstrated that the causal bacteria remain alive upon the outside of the seed-coats and thus lead to infection of the ensuing crop.

Action of Bacillus fluorescens liquefaciens on Asparagin.*—A. Blanchetière finds that *Bacillus fluorescens liquefaciens* flourishes on a medium in which the sole source of carbon and nitrogen is asparagin. This medium is particularly favourable to the production of pigment. After a cultivation of suitable length, about 90 p.c. of the total nitrogen is converted into ammonia, and after a further lapse of time part of this nitrogen undergoes a retrograde metamorphosis.

Fermentable sugars have a retarding action if the medium be rendered alkaline by the addition of calcium carbonate. If the saccharated media be acidified, hydrolysis of the nitrogenous groups is limited to the amido group, and the hydrolysis is much retarded. The manner in which asparagin behaves alone or in the presence of sugars and of ammonia salts leads us to think that the attack on the aspartic molecule when alone is not due to a necessity of microbic development. This molecule is attacked as strongly in the presence of sources of energy more easy to utilize when the chemical conditions necessary to the action of ferments are realizable.

* Ann. Inst. Pasteur, xxxi. (1917) pp. 291–312.

MICROSCOPY.

A. Instruments, Accessories, etc.*

(3) Illuminating and other Apparatus.

Microscope Accessory.†—J. W. Evans, in a paper on the use of a slit in determining refractive indices with the microscope, says certain optical properties of crystals, and more particularly the refractive index, may be determined either in the directions-image, often referred to as the "image in convergent light," or in the ordinary object-image in which the object itself is seen. In the former case, in which the index of refraction is usually determined by means of the critical angle of total-reflection, every point in the image corresponds to a single direction of propagation of the wave-front through the crystal-structure and to the two corresponding directions of vibration. One of these can, however, be eliminated by the insertion of a nicol in an approximate position, and thus all ambiguity in the determination of the refractive index is removed.

In the object-image, however, the wave-fronts of the light by which any point is illuminated have traversed the crystal-structure in an infinite number of different directions, and to each of these correspond two directions of vibration, so that there is no definite refractive index which can be determined, and only approximate results can be obtained whatever the method employed.

This difficulty may be overcome to a considerable extent by placing a diaphragm with a minute aperture in a position on the microscope axis where a directions-image is formed, or in a focus conjugate to such a position, so that the image of the aperture is seen in focus simultaneously with the directions-image, thus allowing only a small well-defined portion of the latter to be visible or to be illuminated.

By moving the diaphragm laterally, that is to say, at right angles to the axis of the microscope, any point of the directions-image may be rendered visible or illuminated to the exclusion of the rest, so that the light which passes is limited to that which has traversed the crystal-structure in what is practically one direction only, and with the help of a nicol it may be restricted to that vibrating in one only of the two corresponding directions of vibration. Then by an alteration of the optical system between the diaphragm and the observer, an object-image may be formed and observed, which is illuminated only by this special light.

The simplest method of applying these principles is to insert the

* This subdivision contains (1) Stands; (2) Eye-pieces and Objectives; (3) Illuminating and other Apparatus; (4) Photomicrography; (5) Microscopical Optics and Manipulation; (6) Miscellaneous.

† Mineralogical Mag., xviii. (1917) pp. 130–2.

diaphragm below the stage in the position in which the iris-diaphragm is usually placed, so that when the Bertrand or Beck lens is inserted or the eye-piece removed it is seen in focus in the directions-image. After the diaphragm has been adjusted as desired, the Bertrand or Beck lens is removed or the eye-piece replaced, and the object-image is seen illuminated only by the vibrations which it is desired to investigate.

If the Bertrand lens be employed to form a directions-image in the focus of the eye-piece, the diaphragm may be placed in that position, and the object-image, formed above the eye-piece, may then be observed with a suitable lens. This image is, however, in the ordinary microscope too high above the eye-piece to be seen with a fixed lens such as the Beck lens without an extra tube, and it is small and ill-defined.*

The chief objection to these methods of isolating a particular direction of vibration is the great loss of light which they involve, causing the illumination to be comparatively feeble even with a powerful source of light.

Where, however, a thin section is cut at right angles to a plane of optical symmetry, or, what comes to the same thing, a grain is so orientated that a plane of optical symmetry is at right angles to the microscope stage, the direction of vibration at right angles to the plane of optical symmetry may be isolated by means of a diaphragm with a fine slit instead of a small perforation. The slit may be adjustable in the same manner as that of a spectroscope, or the diaphragm may be formed by a metal slide with slits of different widths, which can be used as desired.

The slit is placed in a position of parallelism with the plane of optical symmetry, with the result that all the paths of the light which passes it and illuminates the portion of the object in the axis of the microscope are approximately in that plane. It must therefore, whatever path it follows, have one of its directions of vibration practically normal to the plane in question, and the other in the plane and at right angles to its path. If now a Nicol's prism be inserted in the microscope in such a position that the vibrations of the light which traverses it are at right angles to the plane of optical symmetry, the vibrations in that plane will be eliminated, and the image will be illuminated only by vibrations at right angles to it, which have, of course, all the same refractive index, so that definite results will be obtained.

If the section is at right angles to two planes of optical symmetry, or, what comes to the same thing, if two such planes are parallel to the axis of the microscope, each may in turn be placed parallel to the slit, and thus two indices of refraction may be determined. These will be two out of the three principal indices of refraction, that is to say, those of the three lines or axes of optical symmetry.

In the case of uniaxial crystals, the index of refraction of the ordinary or basal vibrations may be observed in any section, while in a section parallel to the axis of optical symmetry, those of both the ordinary and the extraordinary axial vibrations may be determined.

These methods are applicable to the Chaulnes procedure for deter-

* J. W. Evans, "The Isolation of the Directions-image of Small Objects," Mineralogical Mag., xviii. (1916) p. 45.

mining the refractive index, and they eliminate the bifocal effects described by Sorby.* If they are employed with the Schröder van der Kolk method, the finger or other screen must be introduced along the direction of the length of the slit.

If the slit is employed in the Beck method, it must be parallel to the boundary along which the effects are to be obtained. The result is that it is only occasionally that the principles described above can be applied. The slit has, however, in this case another important recommendation. When parallel to the boundary of the minerals to be compared, it gives as definite results as a circular aperture with a diameter equal to its width, and at the same time the field is much better illuminated.

Dr. Tutton pointed out at the reading of the paper that the slit could also be employed to obtain monochromatic light for microscope studies of crystals, if the spectrum from a prism were thrown upon it in such a manner that the individual colours were parallel to the slit and the length of the spectrum at right angles to it.

(5) Microscopical Optics and Manipulation.

Improved Immersion Oil.†—Flatters and Garnott have introduced this oil to replace the thickened cedar-wood oil, and it answers the purpose of an immersion oil in microscopical examinations. Its refractive index is 1·510 at 30° C.; it keeps clear even in the cold, is easily removed from the slide, and does not readily dry. It shows a neutral reaction when tested with litmus-paper.

Orthostereoscopic Image.‡—E. M. Nelson writes as follows:—"With reference to 'N. E. B.'s' remarks on the value and beauty of a good orthostereoscopic image in a microscope, every real lover of that instrument will agree; microscopists will also assent to his praise of the Wenham form of instrument, although some may not be prepared to follow his advocacy of its employment with the highest powers. The position of the Wenham seems to be that it is a very good form of instrument. Its best effects are obtained with objectives from 1 in. to 4·10 in., a range of the most useful powers; but on either side of this there is a falling off. Nevertheless, it has an advantage not possessed by all the other forms, viz. that it can be instantly converted to a monocular; there is further the advantage of its simplicity of construction by a single prism. The sole reason why it has been so universally condemned by the professional microscopists in this country is that it is not used on the Continent! The reason why it is not adopted on the Continent is simply that it cannot be applied to the short-tube microscope. There is, as 'N. E. B.' points out, not the slightest justification in the statement that a Wenham cannot be advantageously used with apertures greater than 0·34 N.A.

"Here are the results of experiments made with three kinds of binoculars, carefully adjusted to the same magnifying powers. The

* H. C. Sorby, Mineralogical Mag., i. (1877) pp. 97; xv. (1909) p. 189.
† Lancet, Sept. 1, 1917, p. 350.
‡ English Mechanic, cvi. (1917) pp. 17, 41.

first, a Wenham, $\frac{2}{3}$ objective, 0·24 N.A., A eye-piece; the second, a Greenough, 25 mm. objective, No. 4 eye-piece: the third a Leitz new binocular, No. 2 objective, 0·17 N.A., and No. 4 eye-piece. There was little to choose between the Greenough and the Wenham, the Wenham being at its best point; the Leitz gave a very sharp image, but, strange to say, it appeared much more magnified than the others. (The powers were all re-measured by projection and found to be alike.) In order to bring the apparent size of the Wenham equal to that of the Leitz B eye-piece had to be used. The Wenham image appeared, perhaps, a trifle larger than that of the Greenough, but the difference, if any, was slight. It will be noticed that the aperture of the $\frac{2}{3}$ on the Wenham was double that of the 25 mm. objectives on the Greenough, and greater than that of the No. 2 on the Leitz.

"The powers were then changed, a Baker $1\frac{1}{2}$ (0·2 N.A.) and A eye-piece on the Wenham; 40 mm. objectives and No. 4 eye-pieces on the Greenough; a No. 1 (0·11 N.A.) and 26 mm. eye-pieces on the Leitz. Here, notwithstanding that the aperture of the $1\frac{1}{2}$ on the Wenham was almost N.A. 0·2, yet the Greenough gave the better stereoscopic image; the objective on the Wenham was changed for a low-angle single combination projection objective with the expected result, that there was very little stereoscopic effect left. The Leitz image, as before, was quite sharp. With the Leitz a reduction of the interpupilliary distance of $1\frac{1}{2}$ mm. gives full orthostereoscopic effects, and an increase of the distance by $1\frac{1}{2}$ mm. gives pseudo-stereoscopic effects.

"There is not the least doubt that the new parallel tube binoculars will give by the Mercer method stereoscopic effects either ortho or pseudo; and there is the means of easily turning them on or off, or of having no stereoscopic effect, at pleasure. In practice this microscope is most comfortably used with a little—that is, $\frac{1}{2}$ or $\frac{3}{4}$ mm.—reduction of interpupilliary distance, which gives a certain amount of stereoscopic effect without flickering of the image or eye-strain. The diameters of the fields were: Wenham 18, Greenough 17, and Leitz 16 hundredths of an inch, and the powers were all the same. The same object was used in all the experiments, viz. an arranged slide of *Polycistines* with the same opaque side mirror illuminator.

"The higher powers were then replaced, and the diatoms named by 'N. E. B.' were examined upon a dark ground with precisely the same results. A *Navicula* or *Pinnularia nobilis* on the same slide was resolved in a vertical position, but not when horizontal with the Wenham, as the prism cuts off half the aperture horizontally, but the Leitz with the lens of less aperture resolved it in any position. We see, therefore, that with an object, in which there is fine detail, the Wenham fails, whilst with a coarse object, such as *Polycistines*, it is able to hold its own. This account of what these binoculars are capable of doing is quite unbiassed, for I have no axe to grind. Neither the Beck nor the Watson-Ives binoculars are included, as I have never seen them, but the other three are on the table as I write. The measurements of the diameters of the fields are very interesting, and are what no microscopist would have predicted, for the A eye-pieces were those of Powell's No. 1 size, and the others were of the Continental form.

"In the preceding experiments with the binoculars, low power and coarse objects were used; the following, however, were made with diatoms having finer details requiring higher powers. First a *P. angulatum* (dry) was set up under a monocular with an achromatic $\frac{1}{6}$ with a correction collar and C eye-piece, a dry condenser axial light, cone about $\frac{1}{2}$, no stop or slot. A good image was obtained, the dots were distinct and clear, with no tendency to run into lines in any direction, which may be taken as evidence of a good lens and good definition. The Wenham prism was now pushed in, and the image went to pieces directly. This might have been expected for the reason previously given, viz. that half the horizontal aperture of the objective had been cut off by the prism; the lens had an aperture of 0·85 N.A., the half of which is 0·43, an amount insufficient to resolve the *P. angulatum*. So the conditions were that there was ample aperture for resolution in the vertical, but insufficient in the horizontal direction, and the image showed it. A coarser object, *P. formosum*, in balsam, was then tried with the same lens in the same manner. Under the monocular the image was bright and distinct, the dots were nice and black, and the silex white, without any running into lines or blurring of any sort. When the prism was pushed home the image was (to use a modern term) rotten. The best thing that could be done was to equalize the error by placing the directions of the rows of dots about 45° to the vertical. Even when this was done the image was very poor.

"As the experiments with these comparatively coarse details failed, they were not pushed further on more difficult objects. These objects under the parallel-tube binocular were not mutilated to the same extent as they had been under the Wenham. There was a slight loss of sharpness, but the dots were there and did not run into lines. With high-power images with this microscope the better plan is to set the tubes for full orthostereoscopic vision, and then, when the eye has realized the form of the object, to increase the interpupiliary distance, and, although there will be less orthostereoscopism, the mind will hold the form of the object. These experiments have not altered the opinion I have held for many years with regard to the Wenham binocular, viz. that it is a valuable instrument; it is working at its best with the most useful lenses, viz. $\frac{2}{3}$, and low-angled $\frac{1}{2}$-inch. With powers lower than the 1-in. the orthostereoscopic effect decreases; its upper useful limit seems to be reached (only so far as my own experience and instrument go) with a $\frac{1}{3}$ of 0·65 N.A.

"Either 'N. E. B.'s' microscope differs from mine, or he has some way of working it with which I am not acquainted. I would very much like to meet him some day and compare notes. I quite agree with him with regard to the beauty of the *Aulisci.* I was the first to discover the fine structure in the processes and the first to photograph it. The photograph used to hang on the wall at the R.M.S., but it may not be there now. Grevill's *Auliscus* under a $\frac{2}{3}$ on a dark ground is indeed a most beautiful object. It is like a sapphire brooch with diamond points; and, as 'N. E. B.' says, there are many very beautiful forms in this genus.

"If 'N. E. B.' wants something quite new, if he will examine an

Actinoptychus splendens (formerly *Actinosphenia splendens*) with 10 rays, with a 3-in. and D eye-piece on a dark ground, with a very low-power condenser, say the back lens only of an Abbe, and a small stop, he will see the aulax beautifully shown white. This diatom is an excellent test for $\frac{2}{3}$, $\frac{1}{2}$, and 4-10 objectives when seen on dark ground; the aulax is now black, and should be clean-cut in all azimuths and quite sharp. If 'N. E. B.' will also examine *Hyalodiscus maximus* on a dark ground with D eye-piece, he will see the six rays, and a *Symbolophora trinitatis* gives 12 rays; by this means the rays in other diatoms may be detected."

B. Technique.*

(1) Collecting Objects, including Culture Processes.

Collection of Bdelloid and other Rotifera.†—D. Bryce's notes are intended to widen the interest of the pond-life worker who has hitherto confined himself to collections by means of a net or of the simple dipping. After a brief historical sketch of the work accomplished by earlier British microscopists in connexion with Rotifera, he draws special attention to C. F. Rousselet's various lists (published from time to time in this journal) of species described as new since the publication of Hudson and Gosse's well-known work of 1886–9. He points out that while the greater proportion of these very numerous discoveries have resulted from collections in areas not previously searched, quite a large number of the new species have been found in habitats which are more or less outside the activities of the ordinary collector, and more particularly by the systematic examination of moss. The various methods of collection are accordingly dealt with under the separate headings of pond-work and moss-work.

The former covers work in all water-habitats, whether standing or running water, with the exception of bog-pools. In general pond-work with a net, he finds it desirable to exclude from the catch as many Entomostraca insect larvæ, and water-worms as possible, and therefore uses a double net, an inner of muslin of texture suitable to keep back such unwelcome intruders, and the outer of Indian silk, the latter fitted with an easily detachable metal tube in place of the usual glass tube or bottle. As auxiliary methods he describes, among others, the squeezing of handfuls of *Confervæ* into the net, the "washing" of water-plants, the gathering of any growths on submerged stone or wood, and the examination of *Asellus* and other possible hosts for parasitic forms.

Under moss-work he recalls that certain species of Bdelloid Rotifera had been found in moss by Ehrenberg, but the references thereto escaped attention, being subsequent to his widely known work of 1838. That

* This subdivision contains (1) Collecting Objects, including Culture Processes; (2) Preparing Objects; (3) Cutting, including Embedding and Microtomes; (4) Staining and Injecting; (5) Mounting, including slides, preservative fluids, etc.; (6) Miscellaneous.

† Journ. Quekett Micr. Club, xiii. (1917) pp. 205–30 (2 figs.).

moss was a favourite shelter for Rotifera was rediscovered by Milne and by Zelinka independently about 1886, and it had since been extensively searched by several workers. Many new species of these animals have thereby been discovered, notably by James Murray, until his loss in the ill-fated Stephansson Expedition. With few exceptions the species found in moss do not inhabit ponds or ditches. They belong mostly to the Bdelloida, but some of the Ploima frequently occur in mosses growing in wet places. Even mosses growing in dry positions (on walls, etc.) are tenanted by many rotifers which require the presence of water for active life, and this has become possible from the capacity of most Bdelloid species to protect themselves against desiccation by covering themselves by an air-proof coating of secretion exuded from their skins (as shown long ago by Davis). Mosses are collected from anywhere and from everywhere, either for examination at once or at a later date. Those growing in wet places can be kept in good condition for several weeks, those from dry positions for many months, if treated suitably. Before examination they have to be soaked in added water until the rotifers resume activity. The fullest details are given for this process and the subsequent treatment of the specimens obtained.

For identification most Bdelloida must be seen while feeding and favourably placed, but when first selected they are frequently either so timid that they remain contracted, or so excited that they march about continuously. A system has therefore been adopted of placing them in small cells for a few days until their confidence is restored, when profitable examination can be made. The whole procedure is very fully explained, and the various accessories employed are clearly figured and described.

Cultivating Amœbæ on Solid Media for Class Use.* — M. W. Welch uses a medium which is composed of dextrin 10, dipotassium phosphate 2, magnesium sulphate 0·2, calcium carbonate 0·2, agar 10, distilled water 1000. The amœbæ are fed on azotobacter obtained from a poor soil. A number of trials may be necessary before an amœbae which will feed on azotobacter is found.

Apparatus for Isolation and Cultivation of Anaerobes.† — A. R. Friel has devised the following simple anaerobic apparatus (fig. 1). To expel the air, the apparatus is heated in the autoclave. Air and steam escape through the cut E in the rubber tubing D (Bunsen's valve). When the apparatus cools, the steam condenses and atmospheric pressure closes the slit and prevents air entering. At the same time water rises in the pipette J as far as the glass bead I. To inoculate the culture tube A an emulsion of the material to be cultivated is made in a tube of recently boiled broth or saline, and the end of the pipette J is placed in it and the rubber round the glass bead I is made oval by pressure with the finger and thumb. When the fluid has entered the large tube the pressure is relaxed.

If it be desired to isolate the various species of bacteria in a mixture,

* Trans. Amer. Micr. Soc., xxxvi. (1917) pp. 21–5.
† Lancet, cxciii. (1917) p. 390.

agar is used instead of broth for the culture medium in the large tube. This is melted, and before solidifying is mixed in the manner above described with the emulsion. The agar is then sloped or distributed over the walls of the tube by gentle rotation. Anaerobic cultures can be made from a vein by substituting a hypodermic needle for the pipette.

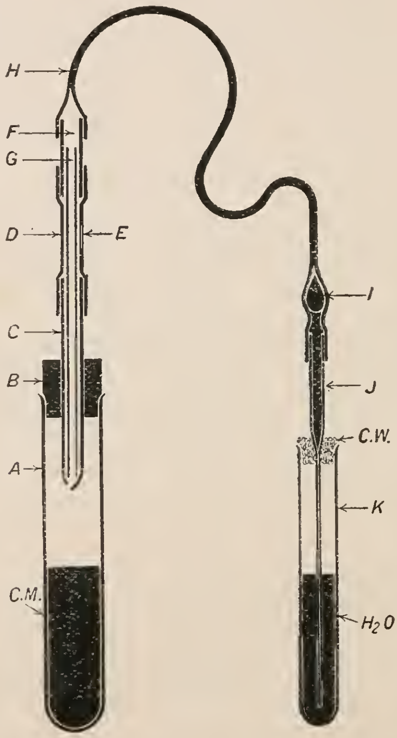

FIG. 1.

Cultivation of the Parasite of Epizootic Lymphangitis.* — A. Boquet and L. Négre state that the most favourable medium for the cultivation of the above organism consists of a filtered decoction of dried horse-dung in water (200 grm. to the litre) containing 1 p.c. pepton, 1·8 p.c. agar, and 4 p.c. glucose. When pus, taken from an unopened abscess, is sown on this medium and incubated at 24° C. to 26° C. the cryptococci are found, after eighteen to twenty-four hours, to increase in size and to become rounded and granular. After forty-eight hours the rounded forms are filled with oily drops and throw out filaments which become segmented and attain a length of from 75 to 100 μ. Sub-cultures do not grow on this medium, however, but if the surface of the horse-dung agar is smeared with pus a few small colonies

* Bull. Soc. Path. Exot., x. (1917) pp. 274–6.

appear after six weeks as the result of sub-culture. They increase slowly in size during the following fortnight. These colonies are spherical, projecting, wrinkled and greyish. They are composed of a tangled mass of mycelial filaments, granular in appearance, and often deformed by chlamydospores. At the extremities and on the walls of these filaments large rounded or oval cells are formed by a process of budding. The bud gradually becomes more and more constricted at its base and finally becomes detached. These free double-walled cells then contain three or four elements identical with the cryptococci found in pus. If these results are verified, the causal organism of epizootic lymphangitis belongs to the genus *Endomyces*.

New Culture Medium for the Gonococcus.*—D. Thomson has devised a new culture medium for the gonococcus which, while giving excellent primary culture, is eminently suitable for the preparation of vaccines. The medium is made up as follows:—1. Prepare nutrient agar (2·5 p.c.) in the ordinary way with bouillon and Witte's pepton (1 p.c.), and render it + 6 acid. 2. Instead of adding to this 0·5 p.c. sodium chloride as is usual, add all the salts natural to the human blood (as in Ringer's solution)—namely, sodium chloride 9 grm., calcium chloride 0·25 grm., and potassium chloride 0·42 grm. per litre. 3. Add glucose 2·5 p.c. This addition in some manner renders the growth much profuse. 4. The nutrient agar with salts and glucose is then tubed, about 4 c.cm. being added to each test-tube. 5. The sterile tubed agar is melted in boiling water, and after allowing it to cool to about 50° C., add 1 c.cm. of human plasma to each tube and mix thoroughly by rolling the tube between the palms. Allow the medium to solidify in a sloping position. For plating, the contents of three tubes may be added to a Petri dish.

Method of obtaining Human Plasma.—When a supply of plasma is required, draw off three-quarters of a test-tube full of blood with all sterile precautions. Have a sterile centrifugal tube ready containing 2 c.cm. of a 2 p.c. solution of sodium citrate. Fill up this centrifugal tube with the freshly drawn blood. Plug it with a sterile cork (keep the corks in alcohol and burn off the alcohol before plugging) and centrifugalize. When the corpuscles are driven down, pipette off the supernatant plasma with a sterile 10 c.cm. pipette and add 1 c.cm. to each tube of agar as indicated above. If the test-tube of blood is three-quarters full there is sufficient left for the Wassermann test after filling the centrifugal tube.

Spontaneous Separation of Blood-clot from Walls of Containing Vessel.†—A. D. Gardner calls attention to the common difficulty experienced in the obtaining of serum from blood owing to the frequent refusal of the clot to separate from the walls of the containing tube or cylinder. In the author's hands the following technique has given uniformly good results:—

Into the tubes or cylinders which are to receive the blood a small

* Lancet, cxciii. (1917).
† Lancet, cxciii. (1917) pp. 51–2.

quantity of melted saline agar is poured. For an ordinary test-tube 1 c.cm. is ample. The agar is a $1\frac{1}{2}$ p.c. solution in 0·85 p.c. NaCl solution. No alkali is added. The tubes are then plugged and sterilized in the autoclave. Shortly before the tubes are to be used the agar is melted by immersing the lower end of the tube in boiling water, and the melted agar is allowed to run up the walls of the tube so as to coat them with a thin film. The excess of agar may be allowed to run back to the bottom of the tube, or, if it be considerable, it may be poured away after removal of the plug.

Either the whole of the inner surface of the tube may thus be coated or there may be left uncoated a longitudinal strip running from the mouth of the tube down some three-quarters of its length and having a width of about one-third of the circumference of the tube. In the former case the whole clot will detach itself from the glass and either sink to the bottom or remain suspended by delicate attachments to the upper pole. In the latter case the clot will almost always adhere firmly to the uncoated strip of glass while separating everywhere else. The serum which separates out is practically always free from any visible trace of hæmoglobin, and it may be left in contact with the clot for several days without acquiring a pink tinge. The coagulation of the blood appears to be slightly delayed by contact with agar, and the quantity of serum obtained in a given time is usually rather less than is the case of a perfect automatic separation from a plain glass surface. But both these disadvantages, in themselves not important, may, if desired, be counteracted by placing the tubes in the incubator at 37° C. for one or two hours after collection of the blood. If this has been performed aseptically the high temperature will do no harm. Once coagulation has taken place separation and contraction occur with striking rapidity. The action of the agar film appears to be purely mechanical. The clot adheres firmly to the film, and the serum which first exudes from the clot filters through the film or passes through cracks in it and separates the film from the wall of the tube. The adhesion of the agar to the clot is often clearly to be seen at the lower pole of the clot when a plug of agar has been left at the bottom of the tube; for the plug can be seen capping the lower pole of the clot and drawn up by it away from the floor of the tube.

Vaccination in Typhus Fever.*—Muriel Robertson has carried out a series of experiments on monkeys with a vaccine derived from the coccus grown from cases of typhus in Belfast by Dr. Penfold in 1914. The monkeys received injections of 150 million, 1000 million, and 10,000 million killed cocci, and finally a living emulsion of 2000 million organisms. It was found, however, that the animals so inoculated did not acquire any immunity against a subsequent intraperitoneal inoculation of blood from a typhus patient. A similar coccus to Penfold's organism was isolated from the blood of two typhus cases examined, but no evidence was obtained of a causal connexion between the coccus found in the blood and the clinical condition known as typhus fever.

* Journ. Pathol. and Bacteriol., xxi. (1917) pp. 171–83.

Vaccine Treatment of Asthma.*—L. Rogers has obtained the most promising results with the use of autogenous vaccines for asthma in Bengal. Cultures were made on glycerin-agar tubes from freshly obtained sputum, two tubes being inoculated from a single loopful, and about six tubes used in each examination to ensure some of the colonies being well separated. On the following day, sub-cultures were made from the fine pneumococcal and streptococcal-like colonies, a number of them being taken up so as to get as many strains as possible in the tubes used for making the vaccine. Occasionally the culture consisted so purely of fine colonies that the vaccine could be prepared from the primary culture, but this was exceptional. If the sub-culture was a thin one, it was smeared over the surface with a platinum loop and reincubated until a uniform thin layer of growth was obtained; 5 c.cm. of sterile salt solution were added to each tube, which were then heated to from 56° to 60° C. for one hour; 0·5 p.c. carbolic acid was added, and, after mixing well, the fluid was put up in doses of 0·5 and 1 c.cm. The first dose was $\frac{1}{2}$ c.cm., which usually contained somewhere about 50 million organisms. If no febrile, but only a little local, reaction occurred, a dose of 1 c.cm. was given after five days and repeated in a week. Occasionally the dose was increased to $1\frac{1}{2}$ or 2 c.cm., but as a rule this was unnecessary. Diplococci and occasional streptococci were the principal organisms found. Notes are given with regard to a series of thirteen cases which received great benefit from this treatment.

(2) Preparing Objects.

Demonstrating Presence of a Hæmogregarine in Blood of Cases of Trench-fever.†—L. Dimond has demonstrated the presence of a gregarine in the venous blood and from liver, spleen and lung puncture. Two c.cm. of blood from the median basilic vein are at once placed into 1·8 p.c. solution of sodium citrate. To this is added saponin in order to cause complete hæmolysis, and to some extent cytolysis, of the leucocytes. The clear red fluid was then centrifuged for one-half to two hours. Films were then made of the deposit. These apparently were stained in the usual way. Unstained preparations were made by first making a ring of parolein in a slide and then putting a drop of the deposit in the centre of a cover-glass, which was then dropped on the ring. This allows the preparation to be examined on the warm stage. A rapid staining method has been used with excellent effect: 0·228 grm. of eosin azur ground up and dissolved in 50 c.cm. of methyl-alcohol. After standing twelve days the supernatant fluid is centrifuged and used to fix and stain the films. After three minutes' action of the stain, the stain is rapidly washed off in distilled water and then dried quickly. The writer also gives a description of the parasite.

(5) Mounting, including Slides, Preservative Fluids, etc.

New Mounting Medium.‡—The medium which C. E. Norton recommends is made from confectioner's glucose. It is a gelatinous

* Practitioner, June, 1916, 7 pp.
† Lancet, Sept. 8, 1917, pp. 382–4 (8 figs.).
‡ Trans. Amer. Micr. Soc., xxxvi. (1917) pp. 42–4.

substance, transparent, and free from colour. As it contains some fibres it is necessary to dilute the glucose with water until it will pass through a paper-filter. The water should be driven off by heat over a water-bath until the glucose is considerably thicker than xylene-balsam. The alcohol should be added until the glucose is of the same consistence as xylene-balsam, or a little thinner. The glucose is not perfectly soluble in strong alcohol, but is soluble in a mixture of water and alcohol. As the glucose is hygroscopic the preparation must be ringed round.

Metallography, etc.

Foundry Irons.*—A general review of the properties of foundry irons in relation to their composition and structure is given by J. E. Johnson. The application of the iron-carbon equilibrium diagram to the study of the phenomena shown by these alloys is first considered, and then summaries are given of the influence of the more common elements found in foundry irons as well as those of special alloying elements. Considerable attention is devoted to the effect of oxygen, which is considered to be most beneficial. Analyses of strong and weak irons of otherwise similar composition showed that the strong irons contained 0·05 to 0·07 p.c. oxygen, while the weak irons contained practically nil. This strengthening action of oxygen is associated with its influence on the graphite, favouring its retention in nodular or short, rounded shapes, having a much less weakening effect than the long thin and consequently very numerous graphite plates found in oxygen-free irons. Oxygen is retained in irons when produced at a low temperature in the furnace. The superiority of cold-blast charcoal irons over coke irons is principally due to their higher oxygen content, owing to the lower temperature of the furnace-hearth rather than to their low sulphur content. Numerous photomicrographs illustrate the different shapes in which graphite occurs. It is also claimed that oxygen, like sulphur, retards graphitization.

Annealing of Arsenical Brass.†—A very thorough investigation of the effects of heat treatment on the structure and mechanical properties of three arsenical brasses of the following compositions :—(*a*) 62·41 p.c. copper, 0·24 p.c. arsenic ; (*b*) 61·07 p.c. copper, 0·139 p.c. arsenic ; (*c*) 62·49 p.c. copper, 0·12 p.c. arsenic, has been made by C. H. Mathewson and E. M. Thalheimer. Each of these alloys successfully withstood both hot and cold working.

In one series of heat-treatments strips of each alloy which had been cold-rolled to a 50 p.c. reduction in thickness were annealed at 450°, 500°, 550°, 600°, 650°, 700°, and 750° C. for fifteen minutes and then quenched. This period of anneal was sufficient to develop equilibrium quantities of the two constituents at the respective temperatures. The mechanical properties and photomicrographs of the structure characteristic of each alloy at these temperatures are given. The mechanical tests show a maximum ductility and minimum tensile strength

* Met. and Chem. Engineering, xv. (1916) Nos. 9, 10, 11, 12 (34 figs.).
† Journ. Inst. Metals, xvi. (1916, 2) pp. 18–65 (45 figs.).

at 550° C. This is the temperature at which the increase in ductility due to re-crystallization and growth of α is neutralized by the decrease due to separation of β. The structures of the arsenical alloys (*b*) and (*c*) quenched from both 650° and 750° show a peculiar arrangement of the β in parallel bands, which is not shown by alloy (*a*) similarly treated. These bands occur in regions previously occupied by α of high zinc content (resulting from the transformation of hot-rolled β bands), and their non-appearance in alloy (*a*) provides evidence that arsenic hinders diffusion in these alloys. The appearance of the banded structure coincides with a sharp drop in the reduction of area, but the elongation is not affected to the same extent. The quenched β phase under high magnification showed a finely lamellar internal structure, which is ascribed to incipient separation of α.

In the second series of heat-treatments cold-rolled strips of each alloy were annealed for fifteen minutes at 700° C. and then cooled at rates of 5°, 20°, 50° and 100° per minute down to temperatures ranging from 650° to 450° C. and then quenched. 450° C. was taken as the lower limit of cooling, as the absorption of metastable β below 450° C. is too slow for any change in properties to take place with the rates of cooling employed. The mechanical properties produced by each heat-treatment in the second series of experiments and photomicrographs of typical structures are given. With alloys (*a*) and (*c*) the ductility increases rapidly with the slower rates of cooling down to 600° C.; cooling to lower temperatures increases the ductility only slightly. Structural observations confirm these results in showing little absorption of β below 600°. With the faster rates of cooling, however, the absorption of β and consequent increase of ductility continues to 450°, but the total amount of β absorbed is less than that which occurs in the corresponding treatment with the slower rates of cooling. Alloy (*b*), which contains nearly twice as much β as the other two alloys when in equilibrium at 700°, showed a gradual increase in ductility down to 450°, whatever rate of cooling was employed. A structure in which β forms a network round the α grains was noted to form by annealing at temperatures above 600° and cooling at rates above 20° per minute; the network was absorbed on cooling at 5° per minute.

The alloys were etched with concentrated ammonia to which a little hydrogen peroxide had been added, and were subsequently given a light wash of ferric-chloride solution to darken the β constituent.

Cast-iron: with Special Reference to Engine Cylinders.*—The features of grey cast-iron which render it such a valuable material for rubbing parts as in cylinders and pistons of internal combustion engines have been studied by J. E. Hurst. Worn gas-engine liner surfaces are covered with small pits. Microscopic examination shows the harder constituents such as phosphide and cementite standing in relief. This is considered to be due to a polishing effect brought about by surface disintegrated material suspended in the film of oil. These projections and other grains composing the surface of the cylinder are eventually loosened and detached, leaving pits. The glazy appearance often conferred on the surface of cylinders which have been in use some time,

* Engineering, ciii. (1917) pp. 40–1, 51–4, 75–6 (21 figs.).

and which is known to be advantageous for smooth running, results from a number of causes, chiefly to breakdown of the surface grains under the influence of alternating stresses, producing a fine structure, harder and less easily disintegrated than the original coarser grained structure. The peculiar anti-frictional properties of cast-iron liner surfaces are probably due to their similarity in structure to that of anti-friction alloys; the hard constituents standing in relief provide support for the load, while the minute hollows resulting from disintegration of the soft constituents provide distributing reservoirs for the oil, ensuring effective lubrication of the whole surface. Micro-structural arrangement will thus have an important influence upon the anti-frictional properties of cast-iron. Owing to the heterogeneous character of cast-iron, the Brinell hardness numeral affords no true indication of its resistance to wear. The method of internal grinding for finishing liner surfaces is superior to machining, as being less liable to leave small pits and surface cracks, which are almost always found however slow the rate of machining. Ground surfaces also possess in a degree the glazy appearance of a finely granular flowed structure.

Machining Properties and Structure of Brass.*—Stampings (hot forged) of 60 : 40 brass having Brinell hardness numbers much above 70 proved difficult to machine, while cold-rolled rods of similar composition were machined readily when the hardness number was as high as 140. An explanation is suggested by O. W. Ellis based upon the differences in structure of the stamping and rod. The arrangement of the β constituent—in irregular distributed crystallites of no definite orientation in the stamping and in elongated almost continuous crystallites parallel to the axis in the rod—produces a similar structure on a transverse surface in both cases, i.e. in cutting through the rod at right angles to the axis, a similar amount of hard material requires to be removed to that required to be removed in cutting a section of the stamping of similar thickness, but the more stable arrangement of the β constituent in the rod offers greater resistance to deformation during Brinell testing.

Structure and Electrical Conductivity of Copper.†—In a general account of the production and properties of electrolytically refined copper, F. Johnson refers to the relation between structure and electrical conductivity. All impurities *per se* have a lowering effect on the conductivity of copper, but those elements which enter into solid solution exert a much greater effect than those such as oxygen which form intercrystalline matrices. Soluble impurities appear further to produce a greater depression of conductivity when they enter into solid solution as a compound, e.g. arsenic, antimony and phosphorus. The effect of soluble impurities is not much different whether they are concentrated at the crystal boundaries as in the cored structure of cast arsenical copper, or whether as in annealed copper diffusion has equalized the concentration throughout. Photomicrographs of copper containing 0·20 p.c. of oxygen as cast and after annealing for five hours at 900° C.

* Journ. Inst. Metals, xvii. (1917, 1) pp. 44–5.
† Journ. Soc. Chem. Industry, xxxvi. (1917) No. 14, pp. 803–8 (2 figs.).

are given showing that annealing causes coalescence of the cuprous oxide globules in the eutectic with consequent diminution of the crystalline continuity of the latter. It is suggested that this structural change partly accounts for the improvement in conductivity of annealed wire over that of the cast copper.

Heat Treatment of Aluminium-bronze.*—The structures of an aluminium-bronze containing 10 p.c. aluminium, after quenching at various temperatures from 500° to 900° C., and also after annealing at various temperatures following quenching at 800° and 900°, are described by A. Portevin and G. Arnou, and illustrated by several photomicrographs. The changes in structure are such as would be anticipated for an alloy of this composition from the equilibrium diagram, showing an eutectoid change at 550° C. The annealed alloy consists of crystals of the α solid solution and a dark etching eutectoid $(\alpha+\gamma)$. Quenching at 500° produces no modification of structure; quenching at temperatures above 550° gives rise to the appearance of a martensitic constituent; and after quenching at 900° the structure is completely martensitic, in which the grain-boundaries of the β constituent stable at high temperatures are clearly marked. Subsequent annealing causes further separation of the α phase, the needles become more numerous and tend to thicken and become rounded. For etching the specimens an alcoholic solution of ferric-chloride was employed. The strength, ductility, hardness, and shock-resisting values of the alloy after each treatment are also given. With the appearance of the martensitic constituent there is an increase in strength and hardness, and within limits an increase also in ductility and resistance to shock.

Case-hardening of Iron by Boron.†—In view of the remarkable hardness of iron-boron alloys the case-hardening of iron by boron, similarly to the case-hardening of iron by carbon, is suggested by N. Tschischewsky. In preliminary experiments—heating in vacuo for two hours at 950° C. with a finely powdered ferro-boron alloy (19 p.c. boron) as case-hardening material—the boron penetrated a low carbon steel to a depth of one millimetre. Microscopic examination showed that the hard white layer of the case-hardened part consists of compact boric-pearlite. The inner part of the layer contains the boron in solution in the ferrite. The cementation was not so rapidly effected when pure amorphous boron was employed as the case-hardening material.

Carbon-Concentration and Exfoliation in the Case-hardening of Steel.‡—E. P. Stenger describes experiments upon the cementation of steel in which four steels of the types usually employed for industrial cementation were heated in the form of thin disks at constant temperature in a carbonizing material, with the object of finding the maximum concentration of carbon in the steels corresponding to each temperature. The temperatures varied from 730° to 1140° C. Microscopical examination of transverse sections of the disks after cementation showed a

* Rev. Métallurgie, xiii. (1916) No. 2, pp. 101–15 (15 figs.).
† Journ. Iron and Steel Inst., xcv. (1917, 1) pp. 185–7 (2 figs.).
‡ Met. and Chem. Engineering, xvi. (1917) No. 8, pp. 425–33 (26 figs.).

segregation of cementite (supersaturated zone) at the extreme edges of some of the disks, but not in others. The view of Giolitti is taken that these segregations are caused by slight oscillations of the temperature during cementation, as in a repeat experiment in which the temperature was made to oscillate between 800° and 950° during heating a much more marked supersaturated zone was obtained. The thickness of this cementite layer seldom exceeds 0·002 inch. (Four disks were clamped together for polishing transverse sections, and thus rounding of the edges and destruction of the cementite zone was avoided.) The carbon content of the disks, determined after grinding a thin layer off the surfaces to remove any cementite layer, are given together with photomicrographs. The saturation content of carbon by cementation at the same temperature varies according to the composition of the steel. None of the carbon-concentration temperature curves coincide with the curve SE of the carbon-iron equilibrium diagram, but lie well to the left of it. This fact confirms the view that the carbon is transmitted to the iron by gases rather than by diffusion of cementite. The phenomenon of exfoliation of case-hardened and quenched objects—i.e. the splitting away of the superficially cemented layer when subjected to shock—is due to the existence of internal stresses arising from the greater increase in volume on hardening of the high carbon exterior as compared with that of the low carbon core. Nickel-steel is exceptional, as the specific gravity after cementing and hardening is greater than that of the same material hardened but not cemented. As the difference is very small however, failures with nickel-steel are less frequent.

Determination of the Line SE in the Iron-carbon Diagram.*— The method adopted by N. Tschischewsky and N. Shulgin in a re-determination of the line SE of the iron-carbon equilibrium diagram, representing the solubility of cementite in γ-iron, was to heat polished specimens of steel to temperatures above and below the line in vacuo, etch at the same temperature with gaseous chlorine, and then rapidly cool in vacuo. This method avoids decarburization at high temperatures of the surface of the specimen. Only two steels, containing 1·25 and 1·50 p.c. carbon respectively, were investigated. Specimens which at the temperature of etching were below the line SE show traces of a pearlitic structure, while those which were above the line show a completely polyhedric structure, more marked the further beyond the line. An average between the two nearest temperatures where one specimen showed a polyhedric structure and the other showed traces of cementite was taken as the required temperature for that composition of alloy. It is concluded that the line SE can be represented as a straight line, assuming the eutectoid point as 0·9 p.c. carbon and 700° C., and the maximum limit of saturation of iron by cementite as 1·7 p.c. carbon and 1130° C. The secondary structures, martensite, troostite, etc., were not observed in these experiments. Several microphotographs are given to show the effects of chlorine etching. It was noted that etched specimens were oxidized after a few minutes' exposure in air, and the etched surfaces were, therefore, protected by varnishing directly after removal from the furnace.

* Journ. Iron and Steel. Inst., xcv. (1917, 1) pp. 189–98 (14 figs.)

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TRANSACTIONS OF THE SOCIETY.

IX.—*Some Methods of Preserving Marine Biological Specimens.*

By F. Martin Duncan, F.R.M.S. F.R.P.S.

(*Read October* 17, 1917.)

The chief object of my present communication is to place on record those methods of preserving and preparing for microscopical examination marine forms of plant and animal life which have proved, during a period of some twenty-five years of intermittent investigations in Marine Biology, most practical and successful. While I do not claim for these methods any great novelty, they have been selected from many with which I have experimented, and represent those which have stood the test of practical application; and it is in the hope that these may be of some help to other workers, may perhaps save new students in this interesting field of research some of the difficulties and disappointments which untried formulæ are apt to present, that I now bring these results before you.

Marine Biology, the study of the teeming life of the sea, is one of the most deeply fascinating branches of natural science, and one which appeals particularly to the microscopist, for it is only by the right use of his beloved instrument that the beauty of form and the various stages in the complex and often romantic life-histories of many of these denizens of the deep stand revealed. It is a branch of scientific research calling for a far wider recognition and support than it has hitherto received in this country, inasmuch that it has a most important bearing upon the successful development of our fisheries, and the continued gathering of that "harvest of the deep" which should form such an all-important food supply to this country. Because of the general public ignorance in these matters, our politicians have had no difficulty or scruple in throwing dust in the eyes of the people as regards the shortage of fish supplies. Like many other matters, it has been readily and loudly proclaimed that the fearful war we are engaged in is responsible for the almost total disappearance of this valuable food supply. That the war is indirectly a cause I am prepared to admit, but the real factor is the criminal neglect of our Government authorities for years past to seriously consider the conservation and development of our home fisheries, or to pay any attention to the repeated warnings of our marine biologists as to the fearful wastage of immature fish under existing conditions of commercial trawling, and the inevitable depletion of what I may term our inshore fisheries. But these are points upon which I must not dilate to-night. I have touched upon them simply to emphasize the economic importance of Marine Biology.

We have a particularly rich sea-weed flora round our British coasts, beautiful and varied in form, size, and colour; and the study of their morphology and life-histories may well attract the attention of the microscopist. A single morning's ramble along the seashore after a violent gale will, at certain seasons of the year, supply him with sufficient material for many a long evening's work with the microscope. In the preservation and preparation of the material collected, the processes selected must depend upon the point to be investigated, i.e. general morphology or the minute structure of the cell-contents. For cytological work I have always found Bouin's solution one of the best fixatives, giving a very beautiful and life-like result, specimens treated with it retaining delicate detail, and staining readily.

The solution is composed of:—Picric acid, saturated aqueous sol., 75 parts; formol, 25 parts; acetic acid, 5 parts.

After fixation, the material may be washed out with alcohol of increasing strength, starting with 50 p.c., 70 p.c., 90 p.c., and absolute alcohol.

For displaying in a natural manner the appearance of the fruiting organs of sea-weeds, I have employed the following method with considerable success for a number of years:—On my work-table I have ready three deep half-plate size porcelain developing dishes, such as are used for the development of photographic plates. Into dishes No. 1 and 2 a supply of clean filtered sea-water is placed, and into No. 3 either tap or filtered sea-water, according to the character of the alga, for some of the red forms are apt to change tint or discharge their colouring matter when placed in tap-water. Into dish No. 1 is placed the whole specimen for a preliminary wash and examination under a pocket lens having a power of $\times 8$ or $\times 10$, which is quite sufficient for selecting purposes. The selected branches bearing the reproductive organs are cut off and placed in dish No. 2 and washed, and then into No. 3 for a final cleansing. A 3×1 glass slip is warmed, a small quantity of "Deane's Medium" poured on to it, the frond of the alga arranged in position therein, and a warmed cover-glass lowered carefully on to it. The slide is then set aside for twenty-four or forty-eight hours, when the superfluous medium can be cleaned off, three rings of Brown cement or good gold-size applied, and when that is dry the slide is finished off with a good black asphalte cement. I have slides prepared in this simple manner some twelve or fourteen years ago which look as fresh as they did on the first day that they were made. "Dean's Medium" can be obtained through any of the vendors of microscopical reagents, and is, I consider, a very useful mounting medium for many botanical preparations, superior to the ordinary glycerin jelly mountant, inasmuch that it permeates the tissues more readily, does not alter their characteristic appearance or shape, and air-bubbles are not so quickly formed.

Formalin, properly used, is undoubtedly one of the most valuable preserving fluids that the marine biologist can employ. It can be diluted with sea-water just as well as with fresh, and has such powerful antiseptic qualities that quite weak solutions can be employed for preserving delicate structures; it does not generally produce any shrinkage of the tissues, and is a great time-saver, as specimens can be placed at once into the solution it is intended to store them in, instead of being passed through a series of different grades of strength, as with alcohol. Unfortunately formalin completely destroys certain kinds of calcareous structures, such as the calcareous skeleton of some larval forms and the spicules in calcareous sponges; therefore it should never be used as a preservative for any larval or adult forms of the Echinodermata or calcareous sponges.

A good deal of confusion exists as regards the actual strength of solutions, owing to the use of the terms "formaldehyde" and "formalin" indiscriminately by many authors, and has been the cause of failure and unsatisfactory results. Ten p.c. formalin and 10 p.c. formaldehyde are by no means one and the same thing, for the latter is two and a-half times the stronger. Commercial formalin as purchased contains a definite quantity of the gaseous formaldehyde, which is generally stated on the manufacturer's label either as formaldehyde 40 p.c. or formaldehyde 30 p.c. The percentage of formaldehyde present should always be ascertained at the time of purchase, and then it is a simple matter to make up solutions of varying percentage. A 10 p.c. solution of formaldehyde is made by adding 300 c.cm. of water to 100 c.cm. of the stock formaldehyde 40 p.c., and this will be found a very useful standard solution to adopt. Personally I always have two standard solutions ready to hand, namely the 10 p.c. and a 4 p.c., made up by adding 1 part formaldehyde 40 p.c. to 9 parts water.

For the life-like preservation of Hydromedusæ formalin is invaluable. At the same time considerable care must be taken if the best results are to be obtained. The method I have employed for some time past, and which has yielded very satisfactory results, as may be seen from the lantern slides and mounts shown to-night, is as follows: On hauling in the tow-net, the contents of the can attached to its base is poured into a wide-mouthed glass jar, and the Hydromedusæ at once picked out by means of pipettes and placed in another glass jar filled with clear sea-water. As it is most important to keep the medusæ in a healthy vigorous condition, it is best to carry out this operation if possible in a shady corner on deck, should it be a hot sunny day, for the little creatures are very sensitive to a rise in temperature. The jar must be perfectly clean, and free from any trace of chemicals. I have found in very hot weather that it is a good plan to wrap several thicknesses of wet flannel round the jar, and to keep the flannel moist with sea-water, the evaporation helping to prevent any appreciable rise of temperature. About half an hour after their removal to the jar, the medusæ should have recovered from the shock and be nicely expanded; should they look sickly, however, then we must at once preserve them, but if in a healthy condition, then they may be left for an hour or two, so that the work can be done on shore.

Many specimens may be quite successfully preserved without the use of an anæsthetic by the gradual addition of formalin to the sea-water in the jar containing them, and this is the best method to adopt on the boat should the medusæ look at all unhealthy. It is most important to keep the medusæ in motion during the addition of the formalin, and this is best done by very gently stirring round and round with a clean glass rod. It is also necessary to know roughly the amount of sea-water in the jar, so that the right amount of formalin may be added—the right proportion is about 10 c.cm. of the 4 p.c. formaldehyde solution to every 100 c.cm. of sea-water in the jar. The formalin must be added slowly, almost drop by drop, while the contents of the jar is kept in motion by gentle stirring, and the motion continued for at least four minutes after the last dose of formalin. The stirring is most important, as it keeps the medusæ off the bottom of the jar, so that they will die in a fairly well-expanded condition, and it also helps to produce an even distribution of the formalin. The medusæ may be left in the jar in which they have been killed for a couple of hours, and should then be transferred to 4 p.c. formaldehyde solution for twenty-four hours or longer, and finally mounted in cells or stored away in 10 p.c. formaldehyde.

Some of the medusæ, no matter how carefully the formalin is added, will contract, and to obtain specimens nicely expanded with the tentacles fully stretched out it will be necessary to use an anæsthetic. For this purpose I place the medusæ in a small Petri dish containing just sufficient sea-water for them to swim freely in. When they are seen to have fully expanded, two drops from a fine pipette containing 1 p.c. solution of hydrochloride of cocaine are added, and the contents of the dish gently stirred with a glass rod. After an interval of five minutes another dose of cocaine solution is added, and this may be repeated a third or fourth time, until there is no contraction of the tentacles on their being gently touched with the fine pipette. Gently stirring, so as to keep the medusæ on the move, now add from 10–20 c.cm. of 4 p.c. formaldehyde solution, and continue stirring for not less than five minutes. With the pipette, and taking up as little of the cocaine contaminated water as possible, transfer the medusæ to a clean dish containing 4 p.c. formaldehyde; they may remain in this for a half-an-hour or longer, and should then be stored in the 10 p.c. formaldehyde solution. On no account should the medusæ remain longer than is absolutely necessary for their complete narcotization in the water containing the anæsthetic, as the cocaine has a softening action on the jelly. This method may also be successfully used for preserving many of the Hydroid Zoophytes with their tentacles fully expanded.

Menthol I have found to be a most useful anæsthetic for many marine animals, such as the Hydroid Zoophytes, simple and compound Ascidians, Holothurians, Anemones, etc. The menthol is slow in action, and therefore rarely causes the animal to contract. The specimen is placed in a glass dish with sufficient clear sea-water to cover it to a depth of an inch or more, and crystals of menthol are then strewn upon the surface of the water. The menthol slowly dissolves, and in about twelve to twenty-four hours, according to the size and sensitiveness of the animal, and the amount of water in the dish, the fully expanded specimen will be sufficiently narcotized to be transferred to a suitable killing and preserving fluid. Menthol may be used with some success for obtaining expanded specimens of the Polyzoa, but I am rather inclined to think that better results are obtained with cocaine as the anæsthetic, and then to kill with 10 p.c. formaldehyde solution. Care must be taken, however, to promptly transfer calcareous forms from the formaldehyde solution to 70 p.c. alcohol.

Specimens in which it is not important to preserve delicate calcareous structure, or are not required for histological work, may be first narcotized and then placed in formol-alcohol, or, if not liable to contract, may be placed at once into this solution, which will kill and preserve them. The formol-alcohol solution is composed of 5 p.c. of commercial formol (40 p.c. formaldehyde) and 70 p.c. alcohol, and is made up by adding 95 c.cm. of 70 p.c. alcohol. Place the specimen directly into the fluid, which must be changed after twenty-four to thirty-six hours.

Of the host of fixative mixtures used by various workers, I consider Bouin's picro-formol solution, of which I have already given the formula, heads the list. It is a splendid fixative, has great power of penetration, and kills very quickly. Material fixed in this fluid is easy of treatment and stains sharply and clearly, which is of immense importance not only histologically, but if accurate photomicrographs are to be obtained. Fixatives containing chromic acid or bichromate salts should not be used, as the material treated in such solutions is always difficult to stain, does not stain sharply, and will often, though visually fairly satisfactory, yield anything but good photomicrographs. Personally, I consider the two best and most useful fixing fluids for general marine biological work are Bouin's picro-formol solution, and the simple saturated solution of corrosive sublimate (bichloride of mercury); the latter, however, must be very thoroughly washed out to obtain the best and sharpest staining. One drawback to the use of the corrosive sublimate solution is that if added to the fluid containing cocaine, a white precipitate will be thrown down on the specimens. This precipitate can, however, be redissolved by washing the specimen in one or two changes of alcohol.

Hydrochloride of cocaine I consider, after long experimenting, to be probably the best anæsthetic for a whole host of the smaller forms of marine life, while menthol comes second, and is particularly valuable for larger marine animals. Alcohol of about 70 p.c. is a useful narcotic in many cases, and I have frequently used it successfully for Hydroids when out of a supply of cocaine. It must be added very slowly drop by drop, however, and the specimen kept under careful observation, as its effect on different subjects varies considerably. With patience and watchfulness it may be employed with considerable success.

Solutions of cocaine do not keep for long, fungoid growths frequently appearing in the fluid after the lapse of a short time. It is advisable, therefore, only to make up small quantities at a time, just sufficient for the work in hand.

For general purposes weak osmic acid is one of the best solutions for preserving marine Protozoa. To the water containing them I add a few drops of a ½ p.c. solution of osmic acid. The organisms are then allowed to settle, or may be separated by means of a centrifuge. They are then stained with dilute picro-carmine, and passed through increasing strengths of alcohol. Many of the Radiolaria are best preserved with corrosive sublimate, *Acanthometra* giving particularly good results. Species of Sphærozoa may be fixed with equal parts of 70 p.c. alcohol and sea-water, with the addition of a little tincture of iodine, or with a 5–15 p.c. solution of corrosive sublimate in sea-water. I have also used Fol's method with some success in dealing with delicate marine Infusoria. To the water containing the organisms a small quantity of a perchloride of iron solution, composed of 1 vol. of tinct. ferri perchlor. B.P., diluted with 5–10 vols. of 70 p.c. alcohol, is added. The organisms may subsequently be stained by treating for twelve to twenty-four hours with alcohol containing a trace of gallic acid.

When time is limited, or in the absence of any suitable means ashore of keeping the contents of the tow-net in a healthy condition for several hours while the various organisms are being sorted out, it is advisable to resort to some wholesale method of quickly preserving the whole of the catch. The following is a simple method which I have employed for many years with considerable success:—The receptacle to contain the catch consists of a glass pickle-jar of some half-gallon capacity, with a good, deep, tight-fitting cork. Through the cork two cleanly-cut holes, about three-quarters of an inch in diameter, are bored, and into one of these a piece of brass tubing six inches in length is tightly fitted, so as to project on either side of the cork. To that end of the tube which will project within the jar, a loose coil of wire, consisting of about half-a-dozen turns, and about two inches diameter and four inches long, is firmly soldered. Over the loose coil is securely fastened to the tubing a small bag of fine muslin or bolting silk. The end of the tubing outside the jar is bent at an angle like a spout. Into the second hole is tightly fitted a stout japanned iron funnel, having a rim eight to ten inches in diameter. Into this funnel the contents of the "can" at the bottom of the tow-net is emptied each time it is drawn inboard, and while the waste water flows out through the brass tube, the little muslin or bolting-silk bag prevents the escape of the animals, and the coil of wire keeps the bag expanded and the animals from becoming jammed against the tube by the outrush of water.

If possible, some of the time between each haul of the tow-net should be devoted to picking out from the collecting-jar, by means of a piece of glass tube or pipette, any Hydromedusæ or other delicate organisms, which should be placed in a separate receptacle, so that they may be treated by one of the processes already described, as they would be injured by the rougher wholesale method of preservation. The rest of the catch may then be emptied into a smaller glass jar, and while stirring gently with a glass rod, so as to keep the organisms on the move, a small quantity of 4 p.c. formaldehyde is added. After stirring for about five minutes allow the plankton to settle at the bottom of the jar. When the jar is not more than half filled with the plankton, pour off as much of the fluid as possible and fill up with 4 p.c. formaldehyde, giving a good stir round so as to thoroughly mix. Each store jar should never be more than half filled with plankton; if the jar is then filled up to the top with the formaldehyde solution, the organisms will keep all right. It is necessary the following day to pour off the 4 p.c. solution, and then fill up with

10 p.c. formaldehyde. Cork down tightly, and the specimens will require no further attention, and are ready at any time for examination.

The larvæ of Echinodermata require special care, as it is important to preserve the calcareous skeleton intact. Pluteus, Auricularia, and Bipinnaria are best killed and fixed by placing in a cold saturated solution of corrosive sublimate, in which they should not remain longer than four minutes. They must then be carefully and thoroughly washed with water and transferred to a dilute cochineal stain only just possessing a perceptible tinge of colour. Mayer's old alcoholic cochineal formula certainly gives the best results, and is prepared as follows: "Cochineal in coarse powder is macerated for several days in alcohol of 70 p.c. For each gramme of the cochineal there is required 8 to 10 c.cm. of the alcohol. Stir frequently. Filter, and the resulting clear, deep red solution is fit for staining." For staining the Echinoderm larvæ it must be further diluted with 70 p.c. alcohol, until only a trace of colour shows. The larvæ may be left in the dilute stain for twelve to twenty-four hours, and then passed through graded alcohols, cleared in oil of cloves or oil of cedar-wood, and mounted in balsam. Mayer's alcoholic cochineal is a very useful stain for many marine organisms, and provided the specimen has not a delicate calcareous skeleton, any overstaining may be reduced by washing in 70 p.c. alcohol, containing $\frac{1}{10}$ p.c. hydrochloric acid, or 1 p.c. acetic acid.

Small sponges collected in the rock-pools I place at once into 1 p.c. solution of osmic acid, in which they remain for about five minutes, and are then placed in strong alcohol, which should be changed twice. Sections stain well in Mayer's alcoholic cochineal. Young Sycones may be fixed in absolute alcohol and stained with alcoholic carmin. For the larvæ of Spongilla I have always found the method used by Delage to give very good results. The larvæ are allowed to settle down on a large cover-glass, and are then fixed for three minutes in absolute alcohol. They are then stained in alcoholic carmin, passed through graded alcohols, cleaned in oil of bergamot, and mounted in balsam.

Anemones, Corals, Alcyonium and Gorgonia are all difficult animals to preserve in an extended condition. I think the best results I have so far obtained are by first narcotizing with menthol, which may take from twelve to twenty-four hours. Sea anemones are then plunged into formalin or formalin-alcohol, in which they are best preserved. Alcyonium and Gorgonia are plunged into hot corrosive sublimate, washed in 70 p.c. alcohol, and stored in 75 to 80 p.c. alcohol.

Holothurians I narcotize with menthol, transfer to 70 p.c. alcohol, and at the same time inject 90 p.c. alcohol through the anus. Store in 70 p.c. alcohol.

Very nice preparations of compound Ascidians with contractile zooids may be made by placing them for a few hours in clean sea-water to expand, narcotizing with menthol, and then plunging into glacial acetic acid. They should be left in the acid for three to ten minutes, according to size, and then lifted out with wooden forceps or the fingers, washed thoroughly in 50 p.c. alcohol, and then passed through successive stronger grades in the usual way. On no account should metal forceps be used, as they will cause a stain on the place of contact with the organism. Salpa, Pyrosoma, and other free-swimming Tunicates may be killed and preserved in 10 p.c. formaldehyde. A small quantity of 1 p.c. solution of chromic acid to the final formalin solution will help to further harden the gelatinous test.

Fish eggs and larvæ should always be preserved in 5 p.c. formaldehyde, as alcohol causes considerable shrinkage and contortion; and they are best mounted in cells filled with 5 p.c. formaldehyde.

Copepoda, Ostracoda, Amphipoda, Isopods, Cirripedes and larval stage of Crustacea generally may be first treated with 5 p.c. formaldehyde in sea-water, and then transferred to 70 p.c. alcohol. Staining must be carried out with caution, as specimens are very easily over-stained. Personally I prefer to use a weak alcoholic picro-carmin stain, and to clear with turpineol, which does not render the specimen too transparent, but beautifully translucent. The specimen may be mounted direct from the turpineol, or first washed in good purified benzol and mounted in balsam.

Some examples of specimens prepared by the foregoing methods are displayed under the series of microscopes.

X.—*On some Foraminifera from the North Sea, etc., dredged by the Fisheries Cruiser "Goldseeker" (International North Sea Investigations—Scotland).* V. *On Thurammina papillata Brady: a Study in Variation.*

By Edward Heron-Allen, F.L.S. F.Z.S. Pres. R.M.S., and Arthur Earland, F.R.M.S.

(*Read November* 21, 1917.)

Plates XXVI.–XXX.

The genus *Thurammina* being essentially of deep-water habit is not represented at all in the majority of the "Goldseeker" dredgings, which are from shallow water adjacent to the Scottish coast-line. In some of the dredgings from the deeper areas of the North Sea and off the west of Scotland, however, *Thurammina* occurs in such abundance and variety as to furnish material sufficient for a critical study and revision of this interesting genus.

A brief synopsis of the published literature of *Thurammina* appears to be a desirable preliminary to our own remarks on the genus, which was established by Brady in 1879 (Ref. 2), for the reception of specimens discovered in material dredged by the "Challenger." Three species, *T. papillata*, *albicans*, and *compressa*, were described, but only the first and last were figured. The genus had probably attracted Brady's attention long previously,

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EXPLANATION OF PLATE XXVI.

FIGS.

1, 2.—Chitinous spherules, the earliest free stage of *Thurammina papillata*. Papillæ absent.

3–6.—*T. papillata* Brady = "Orbuline *Lituola*" of Carpenter. Typical arenaceous spheres in various stages of growth.

7, 8.—Chitinous individuals. Colour, purple. Papillæ imperforate.

9.—Sphere type. Chitin and cement. Colour, metallic copper. Papillæ imperforate.

10.—Sphere type. Built of grey micaceous mud. Papillæ minute, sometimes imperforate or absent.

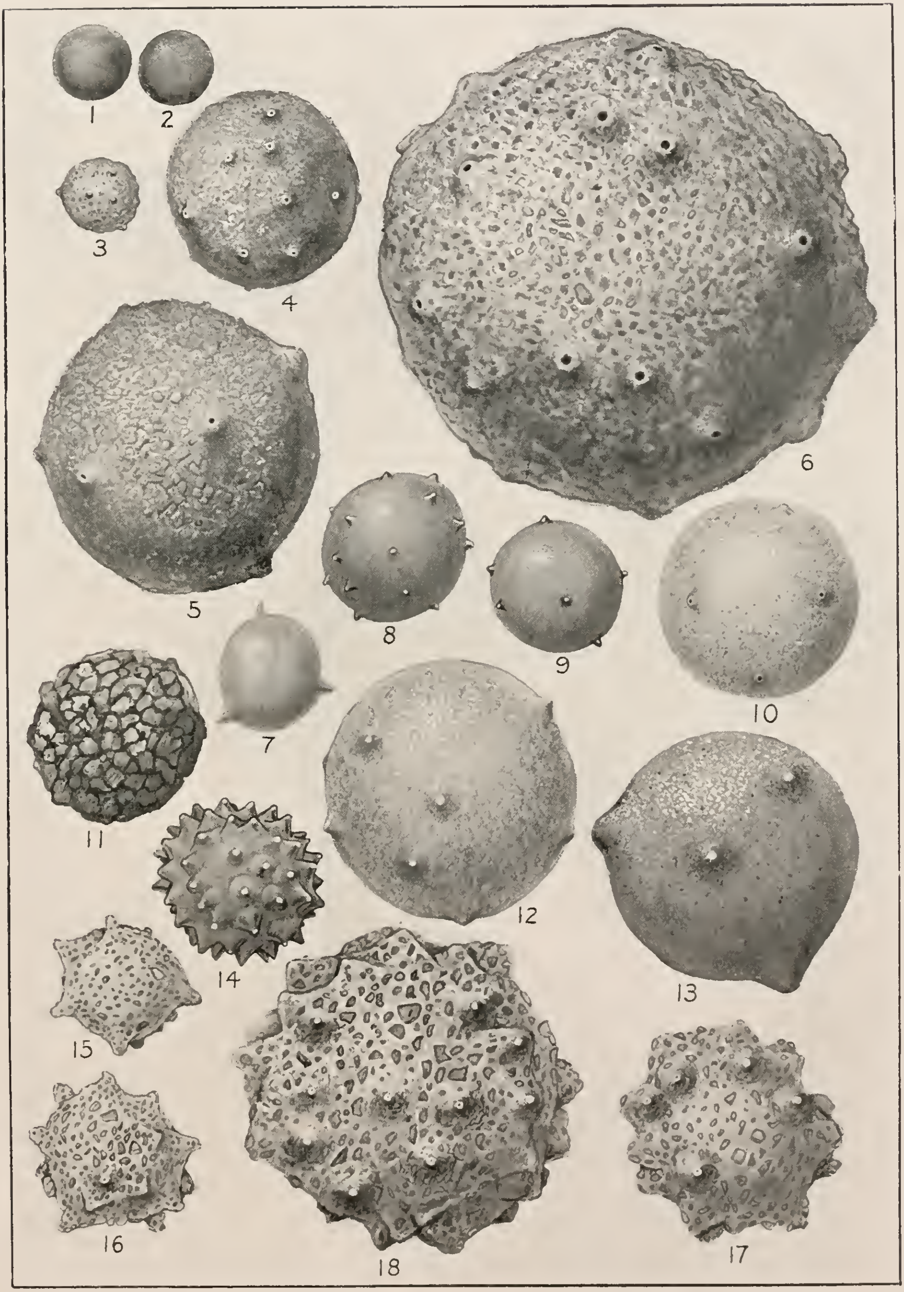
11.—Sphere type. Large sand-grains and black cement. Papillæ absent or very inconspicuous.

12, 13.—Sphere type. Finely arenaceous, with imperforate papillæ.

14.—*T. papillata* var. *castanea* var. nov. Purple chitin, with imperforate papillæ.

15–18.—Ditto. Arenaceous specimens in various stages of development. The prominent papillæ are frequently closed at the apex with fine cement.

All specimens magnified 45 diameters.



J. R. Ford, del.

Thurammina.

[Face p. 530.

for he identifies his species *T. papillata* with the "Orbuline *Lituola*" figured by W. B. Carpenter in "The Microscope" [5th ed. 1875] (Ref. 1).

Brady did not make any attempt in the paper of 1879 to deal with the affinities of *Thurammina*, but in a later paper of the same series published in 1881 (Ref. 3), in which he adumbrated the classification of the Order which was to be adopted in the "Challenger" Monograph, he assigned the genus to the family Lituolidæ. The generic definition of *Thurammina* as published in 1879 is short, but, with a few modifications, sufficient for our present more extensive knowledge of the genus :—

"*Thurammina* (θυρίς: a cell; ἄμμος: sand). Test free or adherent, either consisting of a single rounded chamber, sometimes enveloping a similar one of smaller size, or of two or more (apparently) independent chambers adhering to each other. Texture thin, arenaceous or chitino-arenaceous. Surface beset with numerous perforate nipple-shaped protuberances."

Brady is less happy in his specific description, having apparently failed (perhaps owing to paucity of material) to realize the essentially unstable character of the organism.

A more prolonged study of the subject, aided by a more liberal supply of specimens, would probably have resulted in the suppression of the two species, *T. albicans* and *compressa*, or at any rate in their reduction to varietal rank, for he admits their close relationship to the type species *Thurammina papillata*.

Butschli in 1880 (in Bronn's "Klassen und Ordnungen des Thierreiches") (Ref. 4) reproduces two of Brady's (1879) figures of *T. papillata* (Ref. 2, pl. v, figs. 4 and 6), but ranks the genus with *Psammosphæra*, *Storthosphæra* and *Sorosphæra* in a supplement to his sub-family Globigerinæ.

Carpenter, in the 6th ed. of "The Microscope," published in 1881 (Ref. 5), reproduces the same figures as in 1875, but assigns them to *Thurammina papillata*, "a remarkable imitation of the Orbuline type," and refers to the neatness with which the component sand-grains of small and uniform size are cemented together so as to present a smooth surface both inside and out. His knowledge of the genus was apparently confined to the globular type with prominent nipple-shaped protuberances bearing orifices. In the 8th ed. (1901) (Ref. 31) the "Orbuline *Lituola*" of 1875 has been assigned to Brady's species *T. papillata*.

Uhlig, in 1882 (Ref. 6), refers to Brady's recently described genus *Thurammina*, and records that he had observed in the previous year shells of similar construction in his washings of material from the Jurassic of Brunn. He promises a further study of these forms, which does not appear to have been published in any of his articles which are known to us, or to have been referred to by other authors.

In 1882 Rudolf Haeusler, whose name must always be associated with a genus to which he contributed so much interesting literature, commenced his observations with a note (Ref. 7) in which he recorded the occurrence of Brady's three species, *T. papillata, compressa* and *albicans*, from the Oxfordian of Aargau, and announced two new species, *T. tuberosa* and *canaliculata*, of which, however, no figures or descriptions were given.

In 1883 he published two further papers dealing largely with fossil representatives of the genus (Refs. 8 and 9). He remarks that the Jurassic *Thurammina* differs but little from the recent forms described by Brady, some of the specimens still showing the peculiar yellowish colour.

A further statement that the "recent *T. papillata* is very variable" would seem to point to a knowledge of recent material beyond the published information available at this date, for the figures of Brady and Carpenter do not illustrate any great range of form. (But see our note *infra* upon his paper of 1890.) Haeusler records the finding of a few polythalamous specimens similar to Brady's example, and enlarges our information as to the type species *T. papillata* by some excellent figures of large and coarsely papillate specimens of irregular shape such as occur frequently in some of the "Goldseeker" material, also specimens with produced tubular apertures.

With less reason he creates a new species, *T. hemisphærica*. Test finely arenaceous, very thin, transparent, invariably fixed, nearly hemispherical, monothalamous, with a few indistinct papillæ placed around the margin. Haeusler claims that it is readily distinguishable from fixed varieties of *T. papillata*, but on what appear to be very insufficient grounds.

In the same year, 1883, Haeusler published in English a valuable paper on the Jurassic varieties of *T. papillata* (Ref. 10), illustrated with a plate containing more than thirty figures. The extreme variability of the species was for the first time recognized and suitably illustrated. The paper contains many valuable details as to the distribution and zoological associations of the genus, and it is of great interest to find that such characteristics have remained unchanged throughout long geological epochs. Thus Haeusler records that fossil specimens occur most abundantly in beds full of siliceous sponges, an association which exists to-day, for all the "Goldseeker" dredgings in which *Thurammina* occurs plentifully are marked by an abundant sponge fauna, while dredgings of similar depth in adjacent areas devoid of sponge fauna are also marked by paucity or absence of *Thuramminæ*. The reason of the association is the more obscure as *Thurammina* does not, except under very exceptional circumstances, employ spongial detritus in the construction of its tests. Haeusler also records that *T. papillata* is found in greatest numbers and in the finest condition in the beds with abundant *Hyperamminæ* (*H. vagans* Brady). The same association is noticeable in most of the "Goldseeker" dredgings; wherever *H. vagans* and *H. ramosa* form a considerable percentage of the rhizopodal fauna *Thuramminæ* occur in numbers. The association of the *Hyperamminæ* with a sponge fauna is more readily understood, as both species of *Hyperammina*, and especially *H. ramosa*, employ sponge spicules largely in the construction and armament of their tubes.

Haeusler states that "in comparing a great number of specimens of different ages and localities we find that the species can be divided into a number of groups, each of which contains some characteristic and often remarkably constant varieties. But owing to their great variability most of them can be connected through intermediate forms, forming thus a single series from the simple sphæroidal to the most complicated types. . . . . As the distribution of the recent *T. papillata* is world-wide, its oldest fossil representatives seem to be present in the deep sea sediments all over Europe in countless modifications, many of which have not been found in a recent state. On the other hand, the globular large varieties with small papillæ and very finely arenaceous tests of our existing seas are not known in a fossil condition."

Haeusler records that the tests of all the Jurassic specimens of *T. papillata* are very thin, composed of small grains of quartz sand, neatly fitted together, and united by a colourless brownish or yellow cement. It would thus appear that his fossils, although presenting an equal or even greater range of external form than recent specimens, were more limited in their range of structure. The chitinous tests, devoid of all arenaceous investment which occur in many "Goldseeker" dredgings, do not appear to be represented in the Jurassic, unless, as seems probable, Haeusler is referring to this type of shell when he describes certain specimens as hyaline, a form of structure unknown in recent *Thuramminæ* and incompatible with all we know of the genus.

The Jurassic specimens of *T. papillata* were divided by Haeusler into eleven groups, but without varietal names, and references for each group are given to figures on the plate accompanying the paper. All the groups occur among our "Goldseeker" material.

The same year, 1883, was marked by the publication of Haeusler's paper on the new genus *Thuramminopsis* (Ref. 11). He had already foreshadowed it by a reference to the single species as *Thurammina canaliculata* in the previous year (Ref. 7). Haeusler's type-specimens, if they were ever brought to this country, have apparently disappeared, at any rate enquiries in all likely quarters have proved unfruitful. We are therefore compelled to fall back upon his published description and figures, supplemented by the further information contained in his later reference to the same form in 1890 (Ref. 21). No subsequent discovery of Haeusler's sub-genus *Thuramminopsis* has ever been recorded either in the recent or fossil state.

Thuramminopsis is separated by its author from *Thurammina* mainly on the existence on the exterior of the shell of strictures corresponding with an internal rectangular tube system, which he says reminds him of the siliceous scaffolding of the hexactinellid sponges. From the fact that the tubes often open to the outside he was of the opinion that they were not merely to support the very brittle shell, but also served in the nourishment of the animal, presumably acting as the communication between the contained protoplasmic body and the surrounding medium. But he admits that he was not in a position to confirm this latter theory, as, owing to the bad condition of the fossil shells, he was unable to observe any internal openings to the tubes. He admits the great similarity existing between *Thuramminopsis* and the Jurassic varieties of *Thurammina papillata*, indicating their near relationship, and in the later paper (1890) he lays less stress on the tube system, and his figures are much more irregular and variable, and display a closer affinity to the large irregular specimens of *T. papillata* than his original figures.

In 1884 Brady published his great "Challenger" Monograph (Ref. 12), in which the three species, *T. papillata*, *albicans* and *compressa* described in 1879 (Ref. 2) are more fully dealt with, and for the first time he figured the species *T. albicans*. He adds very little to the information accumulated in the interim by other authors, merely referring to Haeusler's and Uhlig's discoveries without figuring any of the abnormal and irregular types which Haeusler in particular had discovered, and which presumably did not come under his notice when dealing with the "Challenger" material.

In 1885 Haeusler records (Ref. 13) the occurrence of *T. papillata* from the zone of *Terebratula impressa* of Aargau, but adds no further information, and his figure represents only a fragment.

In 1886 Joseph Wright (Ref. 14) lists *T. papillata* as occurring among the Cretaceous Foraminifera of Keady Hill, and published a good figure of the regular spherical type. This is the first Irish Cretaceous record, and the species is described as rare.

T. papillata appears among the species recorded by Brady in his "Synopsis of British Recent Foraminifera" (Ref. 15) published in 1887. Two localities only are furnished, one Scotch and one Irish, ranging between 38 and 110 fathoms—very shallow water for the species.

In 1887 Haeusler records (Ref. 16) delicate spherical tests of *T. papillata* from Hauraki Gulf (New Zealand) shore gatherings, "with short papillæ distributed irregularly all over the surface resembling the passage form of *T. albicans* and *T. papillata* from the upper Jurassic strata."

In 1888 Agassiz refers (Ref. 17) to the occurrence of *T. papillata* in his "Three Cruises of the 'Blake,'" and reproduces one of Brady's figures.

In 1889 Sherborn and Chapman record (Ref. 18) *T. papillata* for the first time from Tertiary beds, from the London Clay of Piccadilly, and figure a spherical type with few irregular papillæ.

In the same year Dreyer, in his Monograph on the organisms with "pylom," or papillate orifices (Ref. 19), refers to Brady's abnormal figure of *T. papillata* (Ref. 12, pl. xxxvi, fig. 12) (in which an internal shell connected by tubes with the outer sphere is figured), as a noteworthy exception to the rule of construction upon which he founds the theory of concentric skeleton systems set forth in the work. He describes Brady's specimen as "the effort of a thalamosphere in the direction of concentric development, but no more, as may be sufficiently concluded from its incomplete development and its quite isolated occurrence."

In 1890 Haeusler published an important Monograph upon the zone of *Ammonites transversarius* of the Swiss Jurassic (Ref. 21). In dealing with *Thurammina* he states that in the Upper Jurassic *T. papillata* is uncommonly variable, and even goes to the extent of stating that it is "incontestably the most variable of all animal species; it is in fact difficult to convince oneself that the countless number of forms can all belong to a single species. The recent *T. papillata* is characteristically much more constant." As we shall see later on, Haeusler's conclusion must have been based largely on the few published figures of recent *Thuramminæ,* and he can have had no experience of the endless variations observable in recent material such as has passed through our hands. It will be remembered that in his 1883 paper (Ref. 8) he observed that "the recent *Thurammina* is very variable." It becomes clear that his observations upon a more extended range of material had led him to alter his views. Dealing with *Thuramminopsis* he defines the difference between this and *Thurammina* as: (1) *Thurammina* always possesses a single hollow chamber; (2) *Thuramminopsis* possesses an internal rectangularly intersecting system of broad cylindrical tubes which correspond with funnel-shaped depressions upon the outer surface of the shell; but he admits the existence of typical individuals devoid of tubes, and also of the surface depressions, which may be taken as passage forms between the two genera. He indicates a further difference between the two genera, in the surface texture of the shell, the particles in *Thurammina* being built in as a mosaic, so that the resultant surface is quite smooth; whilst in *Thuramminopsis* the particles are disposed more irregularly in the cement, so that the surface has a rougher appearance. But, as we shall see from the "Goldseeker" specimens, this distinction has no constant value, many unquestionable specimens of *T. papillata* having a roughly irregular surface; and it would therefore appear from Haeusler's own admissions, coupled with our examination of a series of abnormal recent specimens, that his sub-genus *Thuramminopsis* has little, if any, value from a biological point of view, and that *T. canaliculata* should properly be regarded merely as an extreme modification of *T. papillata.*

In addition to the species already described by himself and Brady, Haeusler in this paper describes and figures two new species: (1) *T. elegantissima,* characterized by the possession of semi-globular shaped chambers attached to a base of finely arenaceous texture, and with a thin glassy shell-wall, which, according to the figure, we should prefer to describe as an agglomeration of simple semi-globular chambers, destitute of actual papillæ; and (2) *T. tuberosa,* which had already been referred to as a *nomen nudum* in 1882 (Ref. 7, p. 227), and in 1885 (Ref. 13, p. 4). The latter is described as "a characteristic form directly connected with the large irregular deeply constricted varieties of *T. papillata,* differing from it in the shape of the chambers, each of which bears two papillæ placed opposite to one another; the sausage-shaped chambers are grouped in a distinctive manner which is only more or less coherent. In only a single case were more than two papillæ observed on a single chamber." Haeusler's figures represent an agglomerated mass of individuals of *T. papillata* with few but abnormally developed papillæ.

EXPLANATION OF PLATE XXVII.

FIGS.

1.—*Thurammina papillata.* Sessile specimen, attached to tube of *Hyperammina ramosa* Brady = *T. hemisphærica* Haeusler.

2.—*T. papillata* var. *compressa* Brady. Specimen with test of cement, metallic copper colour.

3.—Ditto. Specimen with test of grey micaceous mud; no papillæ.

4.—Ditto. Specimen with test built of plates of mica attached to chitinous envelope.

5.—Ditto. Finely arenaceous test.

6.—Ditto. Finely arenaceous test. Specimen with double marginal ring of papillæ separated by groove.

7.—Edge view of fig. 6.

8.—Finely arenaceous specimen, with honeycomb surface ornament. (Cf. var. *favosa* Flint.)

9.—*T. papillata.* Oval form. Large coarsely arenaceous specimen. (Cf. Brady (Ref. 12), pl. xxxvi. fig. 8.)

10, 11.—Abnormal oval specimens, with cement tests and imperforate papillæ. Colour, metallic copper.

12, 13.—Oval forms in copper-coloured cement; imperforate papillæ.

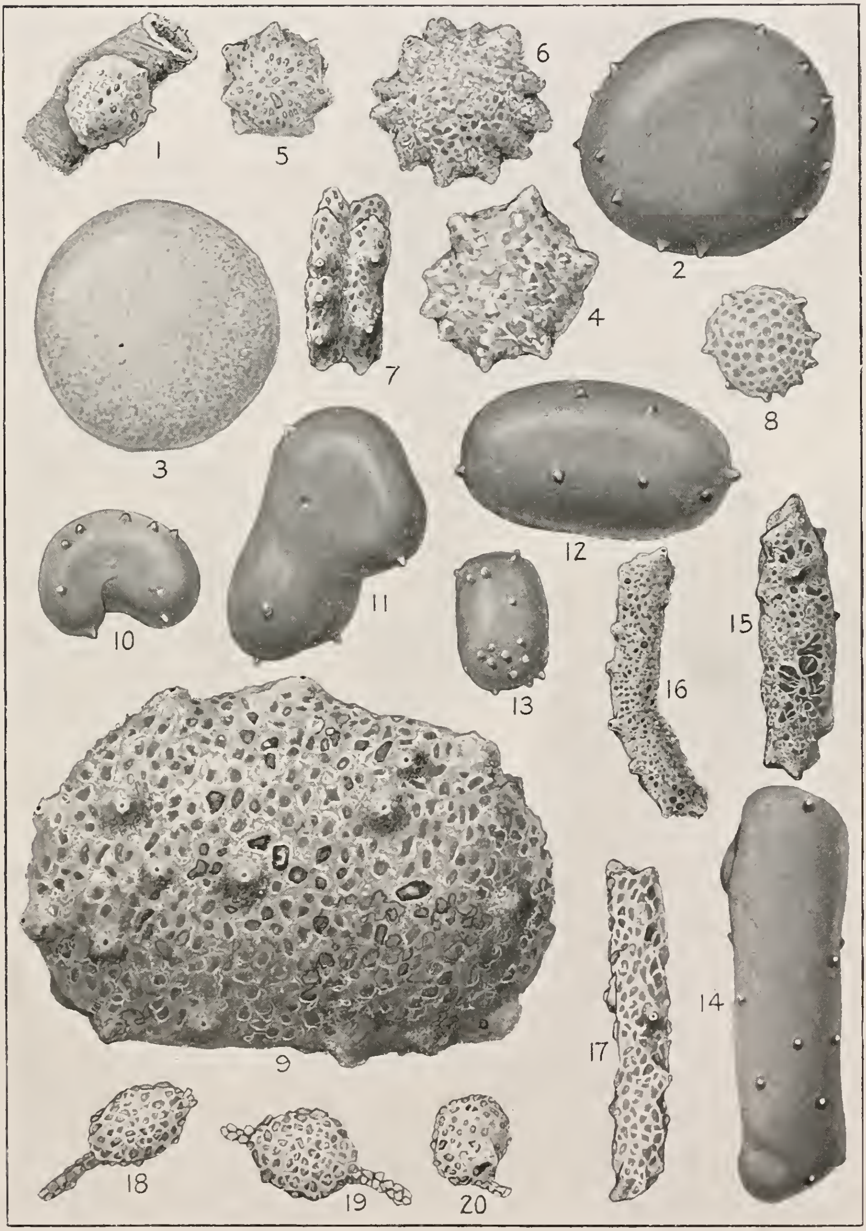
14.—*T. papillata* var. *parallela* var. nov. Specimen with test of chocolate-coloured cement; imperforate papillæ.

15.—Ditto. Test largely micaceous.

16, 17.—Ditto. Specimens with fine and coarse arenaceous tests.

18, 20.—*T. papillata.* Forms with few and abnormally developed papillæ. (Cf. Brady (Ref. 12), pl. xxxvi. fig. 10; and Haeusler (Ref. 21), pl. vi. figs. 12, 13, 16, 23, 25, 26.)

All specimens magnified 45 diameters.



J. R. Ford del.

Thurammina.

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In 1892 Chapman records *T. albicans* (Ref. 23), of small size and very rare, in the upper zones of the Gault of Folkestone.

In 1893 Haeusler summarized his various papers (Ref. 24), and referring to *Thurammina* records that it makes its first appearance in Switzerland in the Lower Lias. In the Calcareous Beds of Aargau (l'Etage Argovienne) *Thuramminæ* appear in extraordinary variety. After the *Sequanien* the genus disappears almost completely. Five species of *Thurammina*—viz. *hemisphærica, albicans, papillata, tuberosa* and *elegantissima*—are recorded as well as *T. canaliculata.*

In the same year Egger (Rep. 25) records *T. papillata* from the west coast of Australia as "rare" in 359 metres, and figures a compressed egg-shaped type with irregularly disposed papillæ of considerable altitude.

Howchin, in his "Census of the Fossil Foraminifera of Australia" (1893) (Ref. 26), records *T. compressa* Brady as rare in three borings of Cretaceous age.

In 1896 Goës, reporting on the Foraminifera of the "Albatross" Expedition (Ref. 27), records a single specimen of *T. papillata* from 724 fms. in the Caribbean Sea, and also figures and describes a new species, *T. crinacea.* It is described as "somewhat wrinkled, tuberculated and beset with short closely arranged spines; sometimes the spines are more scattered and very produced in length. Shape usually globular, seldom ovoid; test sometimes provided with a short neck or shaft. Colour usually grey-yellow, sometimes whitish, with black specks, some of which may be orifices. Wall more or less thin; diameter seldom beyond 0·25 mm., Pacific, 555 to 1879 fms. Not rare." It should be pointed out that Goës himself describes this form with some hesitation; the description and figure have little in common with preconceived opinions of *Thurammina,* but strongly suggest a Radiolarian origin for the specimens. Cushman, writing in 1910 (Ref. 38), takes the same view of the identity of Goës' specimens after an examination of his material, and remarks that the mounted specimens were not easily examined, but some are plainly *Radiolaria,* which are not uncommon of this form and size in the Pacific. *T. erinacea* may therefore be disregarded as far as our inquiry is concerned.

Eimer and Fickert in 1899 (Ref. 28), in their attempt towards a reorganization of the genera and species of the Foraminifera, transferred *Thurammina* to a new family, Kyphamminidæ (κυφὸς = tuberculate), of which it is the sole constituent, but give no opinion as to its affinities.

In the same year Egger (Ref. 29), under the singularly inappropriate name of *Thurammina splendens,* describes a new species from the Chalk Marl of the Bavarian Alps. His figures represent three entirely different forms, which, whatever their real nature may be, are certainly not *Thurammina.* The description refers particularly to the absence of the characteristic papillæ, and both description and figures suggest to us a Radiolarian origin for the specimens.

In 1899 Flint (Ref. 30) figured *T. papillata* from various stations in the Atlantic, and described and figured two new species from the Gulf of Mexico:—1. *T. favosa*, described as "spherical, walls very thin, arenaceous, brown. Surface ornamented with a network of thin prominent ridges extending uniformly over the whole test, forming hexagonal pits. Cavity smooth, apertures numerous, small, at the end of short tubular processes from some of the points of junction of the ridges. Diameter about 0·8 mm." 2. *T. cariosa*, described as "spherical, surface rough, as if eroded, walls rather thick, cavernous. Cavity globular, smooth. Apertures not tubular, colour a dirty brown. Differs from *T. favosa* in the thicker walls and coarser structure, the eroded rather than reticulated surface, the cavernous walls, and the non-tubular orifices. Diameter about 1 mm." Both of Flint's species represent well-marked and persistent types.

Chapman, in 1902 (Ref. 32), briefly summarizes the characteristics of the species and its distribution.

Rhumbler, in 1903 (Ref. 33), attempted a systematic rearrangement of the Arenaceous Foraminifera, and transferred *Thurammina* to his fifth sub-family Saccammininæ, re-naming the genus *Thyrammina*, and giving a list of six recent species.

Kemna, in 1904 (Ref. 34), theorizes on the morphological significance of the papillæ, and regards them as modifications of the tubular rays characteristic of the primitive Astrorhizidæ, and as forming a transition stage towards a truly perforate test. In the same year, 1904 (Ref. 35), Millett records and figures *T. favosa* from shallow water in the Malay Archipelago. He appears to have held strong doubts as to the rhizopodal nature of the organism, but we are fortunately in possession of his specimens and can confirm the identification. The Malay specimens are very minute, and, for their size, thick-walled.

In 1905 Chapman and Howchin, by the record of typical *T. papillata* from the Permo-Carboniferous of Pokolbin, N.S.W., extend the geographical record of the genus backward for a considerable period.

In 1906 Gough (Ref. 37) figures under the name "*Thurammina sp.?*" some small flask-shaped arenaceous forms from shallow water, "most of them being globular, but some being rather more irregular each apparently having only one aperture at the end of a very small neck." He compares them with *Saccammina sphærica* Sars, but remarks that they are of a smaller and finer texture. Neither his figures nor description are very convincing as regards their determination as *Thurammina*. We should be inclined to refer the specimens to *Reophax difflugiformis* Brady.

In 1910 Cushman, in his work on the Foraminifera of the North Pacific Ocean (Ref. 38), records *T. papillata* and *T. albicans* only, and criticizes adversely the rhizopodal origin of *T. erinacea* Goës from that area (Ref. 27, p. 26).

In 1913 we recorded (Ref. 39) two specimens from shallow-water dredgings in the Clare Island District (Ireland), one being of the normal *T. papillata* type, and the other a chitinous variety.

In the same year J. A. Cushman described (Ref. 40) a new species, *T. papyracea*, from "Albatross" Station D. 5613, North of Celebes, 752 fms. It is defined as : "Test spherical, wall extremely thin and delicate, composed of fine sand grains, sponge spicules, and a brownish cement; apertures very small and inconspicuous. Diameter, 1·5 mm. A large species, with a paper-thin wall and very inconspicuous apertures."

Cushman's species is evidently only a pauperate modification of the sphere type of *T. papillata*.

In 1913 Dr. Ludwig Rhumbler, in one of the instalments (Ref. 41) of his monumental work (as yet unfinished, and perhaps doomed to remain incomplete, the death of the author in the present war being reported), reproduces Brady's "Challenger" figure as illustrating the formation of the secondary or outer chamber by a flow of protoplasm from the papillæ of the inner shell, the protoplasm then proceeding to collect sand-grains for the formation of an outer shell, as figured by Brady. He agrees with the theory of Kemna (Ref. 34) as to this. He has not yet actually recorded *Thurammina* from the material of the Plankton Expedition, and it does not appear in the undescribed plates which appeared in Part I. of this work in 1909.

In 1915 we recorded (Ref. 42) a single specimen from Kerimba, Portuguese East Africa (6 fms.), characterized by the virtual absence of papillæ, and another from 10–20 fms., presenting a transition form between *T. papillata* and *T. albicans*.

In 1916 we recorded (Ref. 43) small individuals of the sphere type, both arenaceous and chitinous, from Professor Herdman's West of Scotland shallow-water dredgings.

From the foregoing synopsis, which we believe contains at any rate all the important references, it will be seen that the student of *Thurammina* is not confronted by such a bewildering medley of species as encumbers other genera of the Foraminifera. Rejecting *T. erinacea* Goës and *T. splendens* Egger as organisms of doubtful identity, we are left with some nine specific divisions, or ten including *Thuramminopsis canaliculata*. But the examination of several thousand specimens picked out from "Goldseeker" material has convinced us that in *Thurammina* we are dealing with a protean and polymorphic type, and that it is more impossible even than with other foraminiferal genera to define the characteristics and limitations of a species. Given a sufficient number of specimens it is easy to select a series linking all the published species together. Haeusler appears to have formed the same opinion from the study of his fossil specimens, for he refers repeatedly to the variability and inter-relationship of the species.

We therefore propose:—

1. To retain the earliest described and *figured* species, *T. papillata* Brady, as the type of the genus, and to include under this specific name all *Thuramminæ* hitherto described and figured under various specific names.

2. Where for taxonomic reasons further classification is required, to utilize already published specific names in a purely varietal sense.

3. To abandon certain specific names which are of no value even for varietal classification.

4. To form certain new varietal distinctions for groups which have not hitherto been described or adequately separated from other groups.

Before proceeding with our survey it will be useful to indicate a few stages in the life-history of *Thurammina* ascertained from the examination of numerous sections and balsam-mounted specimens, as the observations throw considerable light on the subsequent appearance of the individuals and their development, and will therefore assist us in our classification.

Thurammina, like all the Arenacea, is a benthic organism. Although from its spherical form, isomorphous with *Orbulina* and many Radiolaria, it might be surmised that it was suited for a pelagic existence, there are no records of its occurrence in this condition even in those early stages before it acquires the arenaceous investment which marks the mature stage of growth, and which of course could only be secreted by a benthic organism. But the initial stages of the organism are passed in a chitinous envelope, and we consider it not improbable that a more careful examination of tow-nettings from suitable localities may result in the discovery of pelagic individuals in the chitinous condition which, as we shall demonstrate, is frequently retained until the organism has attained its full development in size, and has acquired the characteristic oral papillæ.

On sectioning a number of specimens of *Thurammina*, and especially in the case of *T. cariosa* Flint, individuals will be found in which the central cavity contains a number of "gemmules," or minute bodies of a spherical or sometimes of a pointed oval shape and dark shining appearance, loosely aggregated together or attached to the inner wall of the shell (Pl. XXIX, fig. 8). Other specimens will be found with the cavity more or less filled with a reddish mass, like raspberry jam, consisting of similar gemmules, but of larger size (Pl. XXIX, figs. 9, 10). These gemmules are quite different in appearance from the dark protoplasm with metaplastic bodies found in other shells, and we have no doubt that they represent the initial stages of reproduction. In other specimens it will be observed that a limited number of the gemmules have increased in size at the expense of the rest, and have developed into small spherules of chitin, more or less filling the cavity of the specimen, according to their number, which varies in observed specimens from a single chitinous spherule to a crowded mass filling the central cavity (Pl. XXIX, fig. 11). Sometimes a single large chitinous sphere will be found occupying the greater portion of the central cavity. At this stage personal observation necessarily ceases, and we must assume that the chitinous spheres are set free by the resorption of the parent test and commence an independent existence. While in the test the spherules are always chitinous, and present no aperture or sign of papillar formation, nor, as a rule, are any protoplasmic contents visible through the chitin, which varies in colour from almost glassy transparency to a deep violet or purple colour. The colour may be partly due to the thickness of the chitinous wall, which is very variable, ranging from a mere film, so thin as to be collapsible, and to give diffraction colour effects, to a wall having an appreciable thickness, as seen in optical section.

The life-history of the spherules after their liberation is at present obscure. As already stated, we think it not improbable that such spherules will be discovered in pelagic gatherings, and so furnish evidence that *Thurammina*, like its isomorph *Orbulina*, passes the initial thin-walled stages of its career at, or near, the surface, before sinking to the bottom to complete its life-history with an agglutinated shell-wall. The formation of gemmules and spherules has been observed by us in *T. papillata*, *T. albicans*, and *T. cariosa*, and there can be little doubt that it extends to all the other varieties.

The spherules range in size between 0·01 mm., the smallest measured, and 0·2 the largest. The smallest free living chitinous spheres measured were 0·2 mm., but smaller collapsed specimens have been observed. The smallest arenaceous sphere measured was only 0·12 mm.

But although our pelagic theory must await confirmation, the fact remains that such chitinous spherules (Pl. XXVI, fig. 1) are abundant in the fine floated material from the "Goldseeker" stations where *Thurammina* occurs in any numbers, and their subsequent life-history can be followed with some certainty. Continuing to increase in size, they gradually acquire oral papillæ, often marked at the outset by surface perforations only; they secrete investing walls of varying characters, although this arenaceous investment is often postponed until the organism has acquired a comparatively mature condition and assumed those protean shapes which baffle taxonomy. This early and continued chitinous condition is, in our opinion, the key to the problem of relationship between the groups, and is responsible for the protean forms which have been figured, especially by Haeusler, under the name "*papillata.*" The flexible chitinous membrane lying in contact with other organisms, and under the influence of many conditions beyond our imagination, responds to the stimuli, collapses and expands according to its environment, and develops abnormal forms of growth. No other explanation will account for the protean forms obtained from the "Goldseeker" material.

We shall have occasion to refer to the occurrence of associated tests—usually in pairs, but occasionally in groups of three or even four individuals. There is little or no evidence that this phenomenon is in any way connected with the reproduction of the animal. We agree with Brady that it is merely a case of association of two or more individuals which have come into contact with each other, and continued their growth side by side as attached specimens. There is no resorption of the walls of the test at the point of contact to provide free transfusion of the protoplasm between the individuals. Neither sections nor balsam-mounted specimens give any evidence of channels of communication between the two tests beyond the normal papillar openings. It is noteworthy that such associated pairs are usually of identical size, though Brady (Ref. 12) figures an abnormal association, consisting of one large and two smaller individuals (pl. xxxvi, fig. 15). In the variety *T. cariosa* it is also to be observed that the associated pairs combine to form a common spongy layer, which gradually fills up the groove separating the two spheres (Pl. XXIX, fig. 6).

It is worth recording that, in our experience, the individuals of associated pairs are always identical as regards variety. We have no record of any mixed pairs, although instances occur in which *included* shells are of a different nature to the outer sphere. These two observations, and the further fact that in our new variety, *sordida*, the associated individuals of a pair are sometimes bound together by a collapsed chitinous membrane, which probably in life contained both individuals as in a common cyst or bag, may, perhaps, be taken as some evidence towards regarding the association as a sexual process, or even as an alternation of generations. But it would not, in our opinion, be safe to base any deductions upon such isolated records.

Of quite different significance and much greater variety are the instances of budding. Very few cases of budding have come under our observation, but we figure two instances, in one of which the parent sphere of an irregular *haeusleri* type is seen in the act of forming several small individuals, which are but loosely attached to the parent (Pl. XXIX, fig. 16). In the other a regular *castanea* sphere has budded a smaller sphere at one pole, and an irregular test at the other (Pl. XXIX, fig. 17).

Thurammina papillata Brady.

Type, "Orbuline *Lituola*" of Carpenter (Refs. 1 and 5).

Plate XXVI, figs. 1–13.

In the figure of an "Orbuline *Lituola*" figured by Carpenter in 1875 (The Microscope, Ref. 1), we have the original type on which Brady subsequently founded (Ref. 2) his species *Thurammina papillata*, and the figure fortunately represents an organism of very constant shape and of world-wide distribution, and is therefore peculiarly fitted to retain its position as the central type of the genus. Carpenter's figure represents a perfectly spherical thin-shelled test built up of many minute sand-grains, accurately fitted together in a mosaic by a ferruginous cement which gives to the test a well-marked colour, ranging between pale lemon and dark brown, but is never present in sufficient quantity to mask the constituent sand-grains or give a Trochammine finish to the surface, which is always slightly rough and unpolished. The surface of the sphere is beset with a variable number of papillæ, projecting but little from the surface and distinctly perforate. This original figure, resembling our figs. 3–6, Pl. XXVI, we propose to retain as *T. papillata* Brady *type*. It is to be regretted that Brady, although identifying his species *papillata* with Carpenter's earlier published figure, did not adequately figure Carpenter's type either in 1879 or 1884. His figure 7 (Ref. 12) was perhaps intended to represent the typical sphere type, but really represents a characteristic form with imperforate papillæ to which we refer *post.* Brady's other figures represent more or less abnormal forms.

Starting from this central type, variation begins and progresses in many directions, according to the nature of the shell-wall, the number of its papillæ, their shape and size, etc.

Variation in Wall of Sphere. Chitinous and Sub-chitinous Forms.

At "Goldseeker" Stn. IX B, 61° 34′ N. 2° 9′ E. (330 metres), where the type is fairly frequent, we find an interesting series of specimens in which the original chitinous wall is retained without traces of arenaceous investment. They are usually of a violet or purple colour with characteristic papillæ, and generally without visible protoplasmic contents (Pl. XXVI, figs. 7, 8). The chitin varies considerably in thickness, but is usually so thin that the sphere has more or less collapsed in drying. Such specimens occur in less numbers at other stations.

Proceeding from these purely chitinous forms, some specimens of which equal in size the normal *type* as found at this Station, emerge a whole series in which an investing shell has been secreted without the use of constituent visible sand-grains. Such specimens of course pass by imperceptible degrees into the *type*, but two distinct forms are worthy of note as characteristic of this Station, although occasionally found elsewhere. In the first, the wall of the sphere is smooth, and sometimes rather polished, constructed of homogeneous cement, ranging from bright copper to dark chocolate in colour (Pl. XXVI, fig. 9). The second is steel-grey in colour, and with a glazed surface and less prominent, or sometimes hardly perceptible, papillæ. The wall of the test in the last form is apparently thickened with micaceous mud, the particles of which are infinitely small (Pl. XXVI, fig. 10). Yet another form found at this Station and elsewhere presents a sphere almost devoid of papillæ, and nearly black in colour. The shell is constructed of minute and angular sand-grains, giving a glistening appearance to the test. The cement is dark and liberally used (Pl. XXVI, fig. 11).

Brady's figure 7 (pl. xxxvi, Ref. 12) represents a variation which is of fairly frequent occurrence wherever the *type* prevails, and in which the characteristic papillæ are imperforate. In the "Challenger" figure the imperforate papillæ are prominent, but this feature is subject to great variation, and in many of the "Goldseeker" specimens the imperforate papillar areas lie practically flush with the surface of the sphere, from which they can be distinguished owing to a difference in colour, which may be due either to a reduction of the thickness of the wall in this area, or to its lesser homogeneity and absence of cement (Plate XXVI, figs. 12, 13). These imperforate papillæ and papillar areas are, no doubt, permeable to protoplasm, and Kemna (Ref. 34) regards them as analogous to the tubules in the wall of the perforate Foraminifera. It may be remarked that imperforate papillæ and papillar areas are indicated on the interior of the sphere by depressions similar to those on the *type*, but not perforating the shell-wall.

EXPLANATION OF PLATE XXVIII.

FIGS.

1–12.—*Thurammina papillata* var. *haeusleri* var. nov.

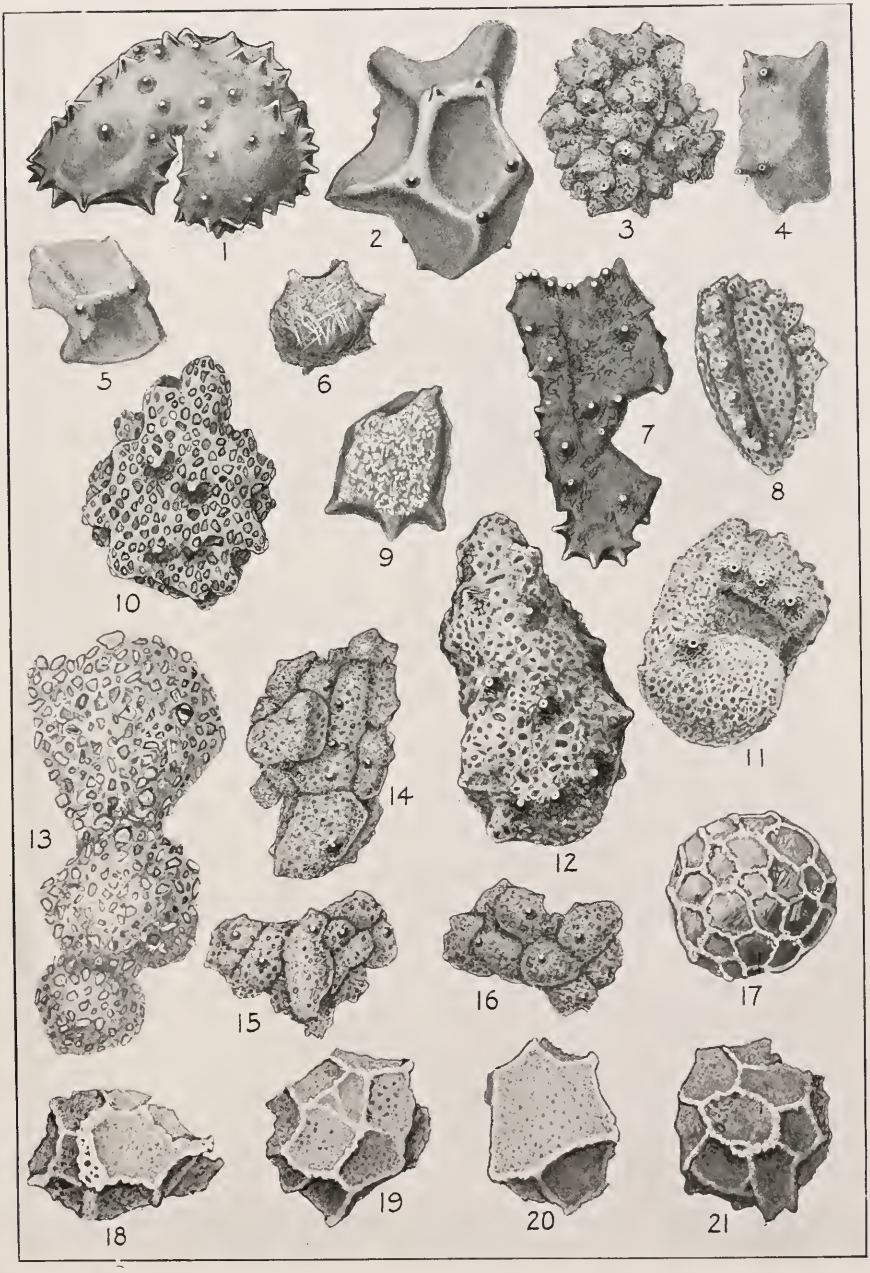
- Figs. 1.—Compressed specimen, with numerous imperforate papillæ. Test of clear brown chitin.
- ,, 2.—Test of cement; pale chocolate colour; papillæ imperforate and few in number.
- ,, 3.—Arenaceous specimen, largely micaceous; numerous papillæ, some perforate.
- ,, 4, 5.—Chitinous specimens.
- ,, 6.—Specimen utilizing sponge-spicules largely for construction of test.
- ,, 7.—Highly compressed dark chitinous specimen.
- ,, 8.—Arenaceous specimen. Imperforate papillæ arranged in rows down three angular edges.
- ,, 9.—Specimen with micaceous test on chitinous foundation.
- ,, 10–12.—Coarsely arenaceous specimens.

13–16.—*T. papillata*. Aggregated individuals. (Cf. *T. tuberosa* Haeusler.)

17. —*T. papillata* var. *favosa* Flint. Chitinous form.

18–21.—*T. papillata* var *murata* var. nov.

All specimens magnified 45 diameters, except fig. 17, which is 90 diameters.



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Thurammina.

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Thurammina papillata var. *castanea* var. nov.

Plate XXVI, figs. 14–18, and Plate XXIX, fig. 17.

As opposed to the last described form, in which the imperforate papillæ are practically flush with the wall of the sphere, we have from many localities a variation which may be referred to Haeusler's figure 7 (Ref. 21, pl. vi), and for which we propose the varietal name *castanea*, because the shell is covered with large conical papillæ, set closely all over the sphere like the spines on a horse-chestnut. Such specimens often attain large size and a comparatively coarse arenaceous investment, but minute specimens are also to be found, also all transition forms, from the purely chitinous to coarsely arenaceous. Brady's curious figure 9 (Ref. 12, pl. xxxvi.) may probably represent a variation of this form, in which the numerous spinous papillæ are confined to one half of the sphere. Specimens intermediate between the smooth and spinous spheres in all stages of size are to be found. It must be distinctly understood that we use varietal names in a taxonomical sense only. They have no biological significance.

Variations from the Sphere Type.

Turning to variations in shape from the sphere we find ourselves in a maze of forms, some of which can be dismissed with brief notice, while others call for more attention.

Thurammina hemisphærica Haeusler (Ref. 9, pl. iv, fig. 14), may, we think, be dismissed with scant ceremony and the specific name discarded. *Thuramminæ* in the attached condition are, in our experience, of rare occurrence, but like many Arenacea, *T. papillata* at times assumes the sessile condition, and as such becomes, of course, hemispherical. We have met with such specimens (Pl. XXVII, fig. 1), but see no object in retaining even a varietal name for sessile individuals.

Thurammina papillata var. *compressa* Brady.

Type, *T. compressa* Brady (Refs. 2 and 12).

Plate XXVII, figs. 2–8.

Thurammina compressa Brady is in a different case, and to some extent a distinctive form and worthy of retention as a varietal name. The variety is characterized by the presence of comparatively large papillæ, situated round the marginal edge of a flattened sphere, and originates in the compression of the *type* sphere at the two poles and the suppression of the papillæ, except those on the equatorial ring, which become largely developed. Such suppressions of the papillæ would result as a matter of course from compression of the sphere, as the papillæ on the marginal edge of a benthic organism would have readiest access to the environmental mud. Kemna (Ref. 34) regards these marginal papillæ as analogous to the ray-like arms of the *Astrorhizidæ.* Both features are so obviously due to the same cause that the analogy seems superfluous. As with the spherical type, the papillæ vary enormously in development, and are sometimes entirely suppressed.

Specimens may often be found in which the papillæ are not confined to the marginal ring, but are scattered more or less over the surface of the disc. Such specimens are not strictly referable to the var. *compressa,* but could be more correctly described as compressed individuals of whatever type they may belong to structurally. We have records of the occurrence of such compressed individuals in nearly every group. They probably arise owing to the collapse and compression of an individual while still in the chitinous condition, and the subsequent development of an arenaceous investment over the collapsed test.

Among the many published figures referred to *T. papillata* some may be dealt with summarily. Thus Brady's figure (Ref. 12, fig. 8, pl. xxxvi) represents an oval variation of the sphere which is of fairly frequent occurrence (Pl. XXVII, figs. 9–13). Such abnormalities may perhaps originate in the fusion of two individual gemmules. The oval may become more produced at the poles so as to form a parallelogram with rounded extremities, and so pass imperceptibly into an elongated tubular type for which we propose the varietal name *parallela.*

Thurammina papillata var. *parallela* var. nov.

Plate XXVII, figs. 14–17.

Test free, elongated and tubular, irregular in section, but generally more or less round, chitinous to finely arenaceous. Papillæ usually most prominent at the extremities. Generally rectilinear, but occasionally curved in outline. Never attaining any great size or coarse investment. The three largest specimens measured were 1·1, 1·03, 1·15 mm. respectively in length, by 0·2, 0·18, 0·2 mm. at point of greatest width.

Arenaceous specimens are easily mistaken at first view for fragments of *Hyperammina* or *Rhabdammina,* but are distinguishable owing to their closed extremities and papillar outgrowths which often form a terminal crown.

Haeusler in 1883 (Ref. 10) figured a number of variations of *T. papillata* which are of great interest, supplemented in 1890 (Ref. 21) by other figures. Figs. 1–4, 10, 25, and 27 of the 1883 paper may be regarded as merely abnormalities of the sphere *type,* such as are to be found everywhere. Fig. 5, which may be compared with Brady's figure (Ref. 12, fig. 10, pl. xxxvi), and the figures (Ref. 21, figs. 12, 13, 16, 23, 25, 26, pl. vi) (1890), represent a rare and abnormal form in which all but one or two of the papillæ are suppressed. and these surviving papillæ are abnormally developed, resulting in a shell, flask-shaped, or resembling a broken chamber of a *Reophax* (Pl. XXVII, figs. 18–20). It occurs sparingly in several "Goldseeker" gatherings, but is hardly worth a varietal name. If Gough's specimens from Lough Larne (Ref. 37) are true *Thuramminæ* they should be referred to this form.

Thurammina papillata var. *haeusleri* var. nov.

Types, *T. papillata* Haeusler (Ref. 10, pl. viii, figs. 5-8, 11, 13–24, and Ref. 21, pl. vi, figs. 14, 18).

Plate XXVIII, figs. 1–12 ; Plate XXIX, fig. 16 ; Plate XXX, fig. 8.

Nearly all the other figures on the plate of Haeusler's 1883 paper (Ref. 10), and the figs. 14, 18, pl. vi., of his 1890 paper (Ref. 21), represent an amorphous and protean type, which we propose to separate under the varietal name *haeusleri*. No description is possible, because no two specimens ever resemble each other, but in general terms it may be stated that the shell is of irregular form, the papillæ are more strongly developed than in the sphere type, and that the shell texture is subject to the same range of variations, covering every gradation between transparent chitin through fine cement and sand to a coarse arenaceous investment. Chitinous specimens often attain a large size and present a formidable investment of stout spinous papillæ, frequently imperforate. Specimens of var. *haeusleri* are generally more or less compressed, but it is not difficult to obtain a series of specimens linking *haeusleri* through var. *castanea* with the sphere *type*. We figure a series of specimens representing some of the innumerable variations of this wild-growing form, which is fairly common at several stations.

This appears to be a convenient place in which to deal with certain figures of Brady (Ref. 12). Plate xxxvi, fig. 12, described as "specimen with an internal chamber," represents an irregular sphere type laid open and showing an internal shell of type intermediate between *haeusleri* and the typical sphere. It has attracted a good deal of attention from subsequent writers (Refs. 19, 34, 41), who have found in it support for various theories. The specimen must, however, be regarded as an abnormality. The internal young shell is within the experience covered by the large series of "Goldseeker" specimens always released by the dissolution of the parent shell before the young attain such size or an arenaceous investment.

Brady's figures 13 and 14, pl. xxxvi (Ref. 12), are of greater interest to us, because they are clearly our variety *haeusleri*. They are described as "primordial chambers from other specimens." It is not clear from this whether they were actually removed from the interior of spheres, or whether Brady identified them as primordial chambers merely on account of their resemblance to the internal shell in fig. 12. If the first alternative is correct, we have definite proof of an alternation of generations between the sphere type and *haeusleri*. The second alternative would merely prove that Brady was acquainted with the variety *haeusleri*, but did not separate it from the sphere type.

Haeusler's remaining species may be quickly dismissed, although we propose to retain the names varietally for taxonomical reasons.

Thurammina papillata var. *tuberosa* Haeusler.

Type, Haeusler (Ref. 21, pl. vi, fig. 24, and pl. vii, figs 6–9).

Plate XXVIII, figs. 13–16.

This is merely an aggregation of specimens of an irregular sphere type, and furnished with few papillæ. Such specimens do not attain the size and complication of Haeusler's figures in any of

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EXPLANATION OF PLATE XXIX.

FIGS.

1–11.—*Thurammina papillata* var. *cariosa* Flint.
- Figs. 1.—Young sphere, showing commencement of reticulated "cavernous layer" of Flint. (*Note*: The reticulated markings are somewhat diagrammatized.)
- ,, 2, 3.—Specimens showing development of "cavernous layer" obscuring the papillæ.
- ,, 4.—Specimen with minutely vesiculated "cavernous layer."
- ,, 5.—Specimen with coarsely vesiculated "cavernous layer."
- ,, 6.—Double specimen, with thick "cavernous layer" obscuring the line of junction between the spheres, and eroded in places.
- ,, 7.—Triple specimen, with finely vesiculated "cavernous layer" completely obscuring the junction of the spheres.
- ,, 8.—Internal view of specimen, showing reproductive gemmules lying within the chitinous membrane.
- ,, 9.—The same, gemmules more developed.
- ,, 10.—Aggregation of gemmules removed from test.
- ,, 11.—Internal view, showing spherules at maximum development filling entire cavity.

12–15.—*Thurammina papillata* var. *albicans* Brady.
- Fig. 12.—Typical.
- ,, 13.—Abnormally large and coarsely papillate.
- ,, 14.—Coarsely arenaceous specimen.
- ,, 15.—Section showing grains of magnetite aggregated in central cavity.

16.—*Thurammina papillata* var. *haeusleri*. Specimen showing four young individuals (one laid open) budding from parent test.

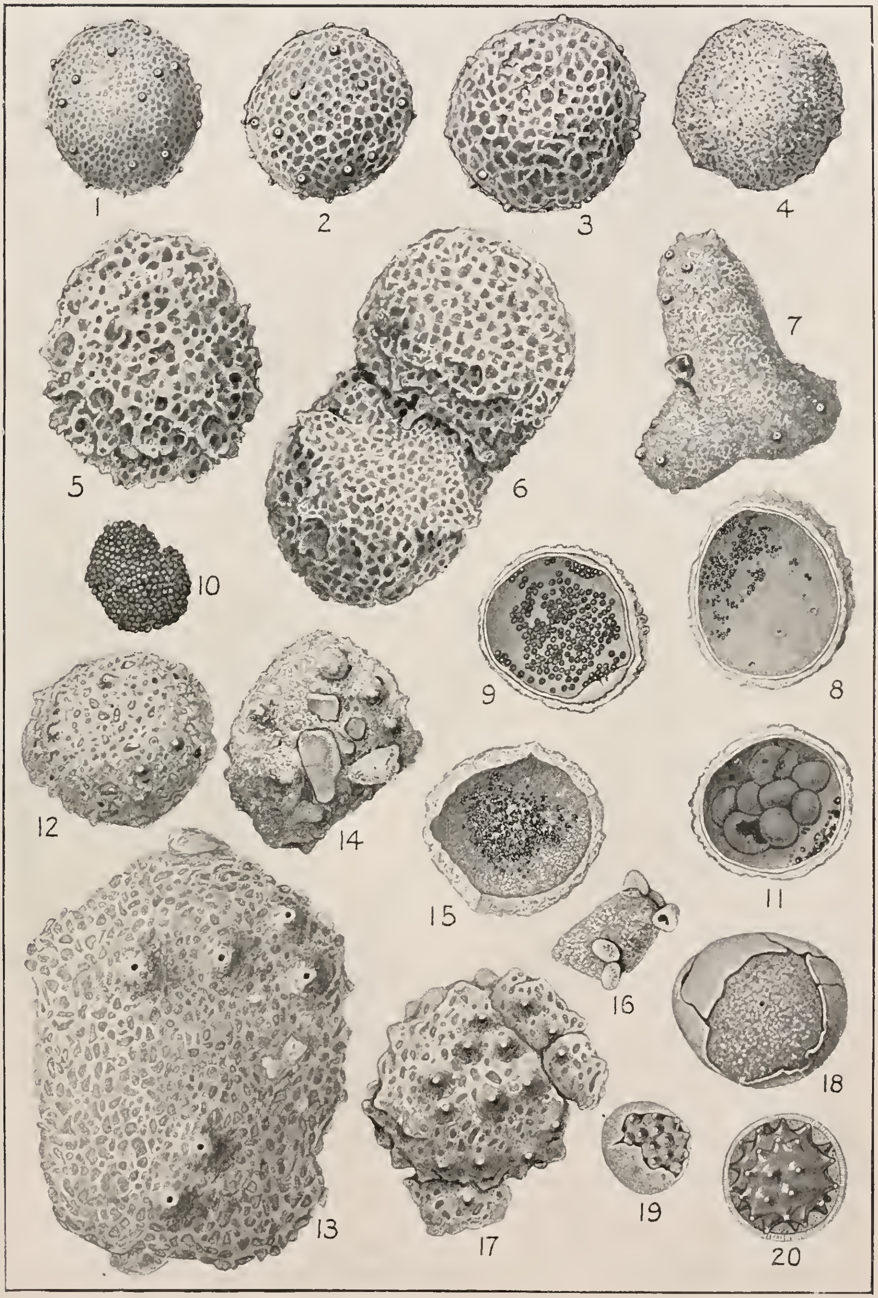
17.—*T. papillata* var. *castanea*. Specimen showing young individuals budding from each side of parent sphere.

18.—*T. papillata*. Sphere type, of chitinous cement construction, enclosing a specimen of *Orbulina universa* d'Orbigny, which entirely fills central cavity of the *Thurammina*.

19.—*T. papillata*. Sphere type, very finely arenaceous and without papillæ, enclosing var. *castanea*, chitinous form.

20.—*T. papillata* var. *castanea*. Chitinous specimen, filling cavity of *Orbulina universa* d'Orbigny.

All specimens magnified 33 diameters.



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our gatherings, but the name may be usefully employed for such abnormal individuals as we figure. These are not uncommon in some gatherings.

Thurammina papillata var. *elegantissima* Haeusler.

Type, Haeusler (Ref. 21, pl. vii, figs. 12 and 13).

Plate XXX, fig. 11.

Haeusler's type represents a flattened aggregation of small spheres devoid of papillæ. We have so far only observed a few specimens referable to this type, one of which we figure. It may be remarked that Haeusler's two species were described by him as "very rare," so it would seem that these abnormal forms were not more frequent as fossils than they are to-day.

Thurammina papillata var. *favosa* Flint.

Type, *T. favosa* Flint (Ref. 30, pl. xxi, fig. 2).

Plate XXVIII, fig. 17.

This variety, characterized by the presence of raised hexagonal meshed walls on the surface of the sphere, would appear to be a very rare variation of the sphere type, there being, so far as we are aware, no records of its discovery, except by Flint, from two Stations in the Gulf of Mexico, in depths of 26 and 420 fms., and by Millett from the Malay Archipelago. It is represented in the "Goldseeker" collections by a few specimens only, including a single chitinous example from Haul 145, Station IX.B, which presents the characteristic honeycomb structure of the surface, and this specimen we figure.

Closely allied to variety *favosa* Flint is a form which occurs rarely in some of the deeper "Goldseeker" dredgings, and for which we propose the varietal name *murata* (muratus = enclosed by walls).

Thurammina papillata var. *murata* var. nov.

Plate XXVIII, figs. 18–21.

Test free, always of irregular shape, generally compressed, but sometimes roughly spherical, consisting of one (in aggregated specimens two or more) chambers of angular shape, enclosed in walls constructed rather loosely of fine grey sand, the angular edges sharp, generally projecting as walls or flanges, which are more or less spongy or cavernous in structure. Apertures situated along the edges of the flanges, sometimes produced as minute papillæ. Specimens vary somewhat in size. Average diameter about 0·48 mm. Width of the projecting flanges about 0·01 mm.

The whole appearance of the specimens suggests that the test has been constructed in the cavities between sand-grains and pebbles on the bottom, and has taken its shape from its environment, but no specimens attached to sand grains have been found. The projecting flanges when perfect have the rounded swollen appearance of wet mortar squeezed out between two rows of bricks in building.

Thurammina papillata var. *cariosa* Flint.

Type, *T. cariosa* Flint (Ref. 30, pl. xxii, fig. 2).

Plate XXIX, figs. 1–11.

Flint's variety *cariosa* is abundant and typical in "Goldseeker" material, and presents a number of interesting features, which are more readily observed in this form than in its associates, owing to the comparative ease with which it may be sectioned, the spongy test being soft as compared with the other types. We have already referred to the occurrence of young individuals inside the parent.

The "Goldseeker" series of *cariosa* present little variation from Flint's type as described and figured, and the variety is not subject to the wild-growing habits of *papillata*. Beyond the occurrence of compressed individuals, and of double, triple and quadruple specimens, practically no variation exists, except in the extent of the development of the secondary reticulated shell-growth which coats the mature test.

Of the early stages of *cariosa* after the release of the chitinous embryos we have no knowledge. The variety recognizable as such makes its first appearance in all the numerous gatherings, in which we find it as an adult shell of greyish, or sometimes pinkish-grey, colour, constructed of the finest mud or sand, and with a matt surface studded with numerous inconspicuous and almost imperforate papillæ, between which the surface of the sphere is covered with fine reticulated markings (Pl. XXIX, fig. 1). At this stage it is practically indistinguishable from some modifications of the sphere type, except for the faint reticulations. It then begins to coat the surface of the sphere with a layer of spongy shell matter (= "cavernous" layer of Flint), concealing the papillæ and giving the surface of the sphere a dirty and eroded appearance (Pl. XXIX, figs. 2, 3). When two or more individuals are in association this spongy matter often fills up the whole of the intervening gap between the spheres. The size of the cavities in the "cavernous layer" is very variable (Pl. XXIX, figs. 4, 5), and on occasions is so large as to resemble a bath-sponge under a 1-in. objective. The interior of the sphere is smooth and lined with a chitinous film, generally pink to brown in colour. We figure a series of specimens.

Thurammina papillata var. *albicans* Brady.

Type, *T. albicans* Brady (Ref. 12, pl. xxxvii, figs. 2–7).

Plate XXIX, figs. 12–15.

Of the recorded species of *Thurammina* only *albicans* Brady remains. This occurs not infrequently in some of the deeper

"Goldseeker" dredgings, where it attains a size considerably greater than Brady records. It appears to be a distinctive form, having little connexion with the typical *papillata*, but in rare instances hardly separable from *cariosa*. The papillæ, when flush with the surface of the test, as they often are, and covered with a loose sandy coat, cannot be distinguished from the outside, but a section will generally reveal a few dimpled pits in the inner wall which mark the position of the superficial papillæ. The papillæ are very few in number, and in some instances perhaps entirely lacking, in which case the form would be indistinguishable from *Storthosphæra*, to which it is possibly nearly allied.

A curious feature observed in connexion with *albicans* is worth recording. The variety appears to have a curious dislike for magnetite. Several specimens which we have laid open contained a number of minute grains of magnetite aggregated in the cavity (Pl. XXIX, fig. 15), the grains having evidently been rejected from the sand collected for the construction of its thick-walled test. This habit may serve to account for the abnormal whiteness of the test of *albicans* as compared with the other varieties. We have observed the same practice in *Storthosphæra*.

Thurammina papillata var. *sordida* var. nov.

Plate XXX, figs. 1–6.

We propose this varietal name for a very characteristic form which occurs frequently in several "Goldseeker" gatherings, and which is very distinctive in appearance.

Test free, spherical or irregularly spherical in shape, colour ranging from nearly white to dark brown, slate, or nearly black. Surface rough, and usually coated with finely adherent mud, but specimens have been seen without any muddy layer on the brown chitin sphere. These chitinous specimens have a crinkly surface, and are sometimes covered with very minute papillæ. Interior of the sphere lined with a brown chitinous membrane which is apparently in several layers. The wall of the test appears to consist of a series of chitinous layers alternating with mud incorporated with chitin. No papillæ visible externally as a rule, but papillar depressions are occasionally visible in sectionized tests. The exterior of the sphere is always very wrinkled and dirty in appearance, and frequently has what appears to be sub-chitinous muddy t reads, or perhaps dried protoplasmic extrusions, irregularly projecting from it. The colour of var. *sordida* is evidently dependent on the nature of its environment, specimens from Haul 228 (1600 metres, *Globigerina* ooze) being nearly white, and having minute *Globigerinæ* attached to the surface layer of mud, while those from Haul 198 (1236 metres, dark brown mud and sand) are very dark in colour.

The central cavity is generally more or less filled with a dried mass of brownish protoplasm, which in a few instances shows signs of breaking up into separate particles—perhaps the commencement of the gemmule stage. Associated pairs have been observed, and, as already mentioned, are sometimes linked together by a chitinous investing membrane.

Size.—Specimens measured varied between 0·50 and 1·50 mm. in diameter.

Thurammina papillata var. *hispida* var. nov.

Plate XXX, fig. 7.

Thurammina does not as a general rule present any evidence *pro* or *contra* the vexed question of selective power, although the *sphere* and *haeusleri* forms exhibit great skill in constructing agglutinated tests, using sand-grains of uniform minute size. It is, therefore, of considerable interest to record the occurrence of a few isolated specimens utilizing sponge spicules as a protective coating to the internal sandy sphere in the identical manner adopted by *Crithionina pisum* var. *hispida* Flint. The few specimens observed are all from one locality, Haul 228, 1600 metres.

Thurammina papillata var. *canaliculata* (Haeusler).

Type, *Thuramminopsis canaliculata* Haeusler (Refs. 11 and 21).

Plate XXX, figs. 9, 10.

We have already indicated our doubts as to the sub-generic value of *Thuramminopsis canaliculata*, and shown how the author of the type appears in his later paper to weaken somewhat in his discrimination between *Thuramminopsis canaliculata* and the abnormal conglomerations of *Thurammina papillata*. The "Goldseeker" material furnishes no specimens presenting the internal tube structure assigned to *Thuramminopsis* by Haeusler, but we have many specimens of aberrant *Thurammina* associations

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EXPLANATION OF PLATE XXX.

FIGS.

1–6.—*Thurammina papillata* var. *sordida* var. nov.
- Fig. 1.—Chitinous sphere collapsed, showing filaments and attached *Globigerinæ*.
- „ 2.—Sub-chitinous sphere, commencing to incrust.
- „ 3.—Incrustation more advanced.
- „ 4, 5.—Spheres entirely incrusted.
- „ 6.—Sectional view (diagrammatic), to show concentric chitin and mud envelopes.

7.—*T. papillata* var. *hispida* var. nov.

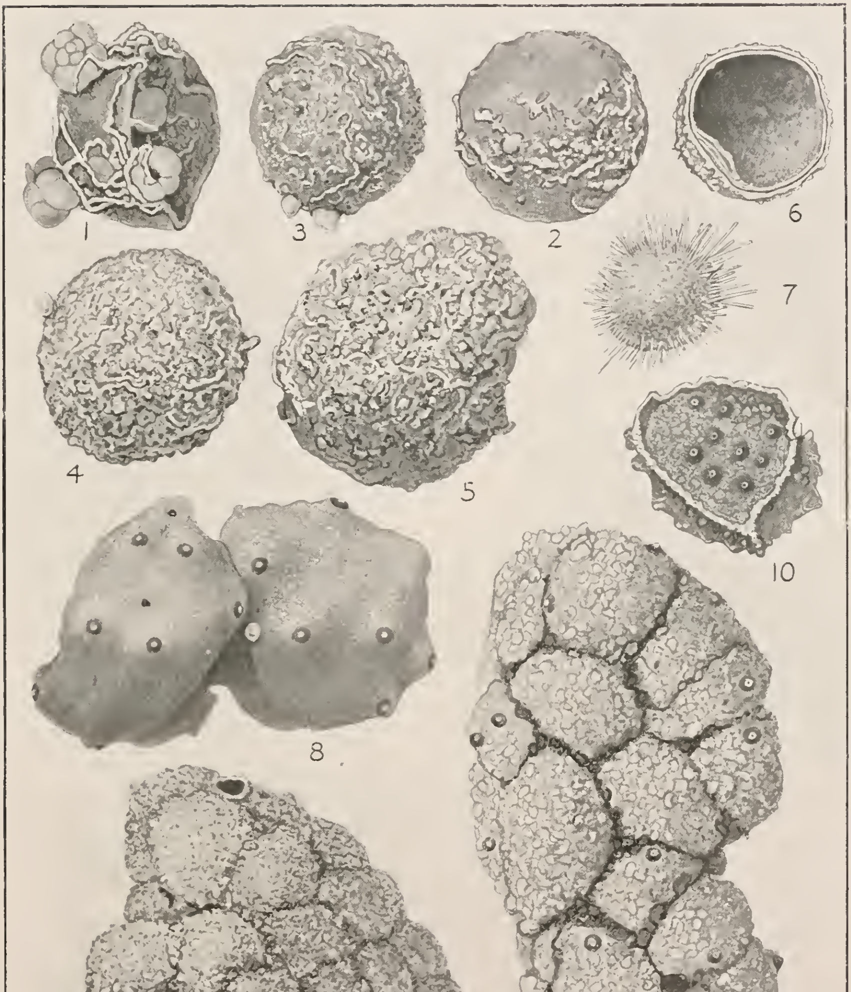
8.—*T. papillata* var. *haeusleri* var. nov. Double specimen.

9.—*T. papillata* var. *canaliculata* Haeusler.

10.—*T. papillata* var. *canaliculata*. Chamber of large specimen laid open, showing internal papillæ, which it is suggested represent the "tubes" of Haeusler.

11.—*T. papillata* var. *elegantissima* Haeusler. A colony of sessile individuals, two being laid open.

All specimens magnified 30 diameters.



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presenting external views almost identical with Haeusler's later figures, and, in the absence of his type specimens, we are figuring some under the varietal name *canaliculata*. This is for taxonomical reasons only, as we regard the specimens merely as abnormal growths.

Summary of Observations.

All hitherto recorded species of the genus *Thurammina*, including *Thuramminopsis canaliculata* Haeusler, are referable to a single specific type, *Thurammina papillata* Brady.

For taxonomical reasons numerous varietal names must be employed, but they have no biological significance.

Thurammina commences its existence with a chitinous wall, which is persistent through life, and when an agglutinated shell is formed continues as a lining to the shell.

The wall, whether chitinous or adventitous, is perforate. The perforations may be of the most minute size, or they may take the form of coarse external papillæ.

Among the "Goldseeker" specimens are several which present great biological interest, and raise questions of relationship and development to which there is no present answer.

We figure them for purposes of future reference.

1. *Orbulina* within *T. papillata* of a thin-walled sphere type (Pl. XXIX, fig. 18.). The *Orbulina* is a thick-walled benthic specimen, the *Thurammina* of a semi-chitinous type without visible papillæ or constituent sand-grains. Although the *Thurammina* is, no doubt, more or less flexible, it is difficult to imagine how the *Orbulina*, which fits tightly inside the sphere, could have become accidentally associated with the *Thurammina* through the small fractured opening to be observed. If there is no connexion between the life-history of the two genera—and we have at present no other evidence in support of such a theory—the only explanation possible seems to be the continued development in size of the *Orbulina* after becoming interned as a young individual in the cavity of a broken *Thurammina*.

2. A chitinous *T. papillata* var. *castanca* inside *Orbulina* (Pl. XXIX, fig. 20). We prefer to regard the association as accidental, although the accuracy with which the *Thurammina* fills the entire cavity of the hemisphere, and the chances against such an accidental association, appear remarkable. On any other supposition this specimen must be regarded as the converse of the previously noted abnormality, and would entail belief in an Alternation of Generations between *Orbulina* and *Thurammina*.

3. A chitinous *T. papillata* of a coarsely papillate type (near var. *castanea*), enclosed in and nearly filling the cavity of a sub-chitinous individual of a smooth thin-walled *sphere* type, devoid of papillæ

(Pl. XXIX, fig. 19). We think there can be no doubt that the internal spinous individual has developed from a spherule secreted by the smooth-shelled parent, and that the specimen may be regarded as proof of the biological identity of these two dissimilar forms, and of the small value to be attached to the development of papillæ. Perhaps, also, as proof of an alternation between these two forms.

References.

1. W. B. Carpenter. — The Microscope and its Revelations. 5th ed. London, 1875, pp. 533 and 535 (figs. 273 *g*, *h*.).
2. H. B. Brady.—Reticularian Rhizopoda of the "Challenger" Expedition, pt. 1, 1879. Quart. Journ. Micr. Sci., n.s. vol. xix. pp. 45, 46, pl. v, figs. 4–9.
3. —— Ibid., pt. 3 (1881). Quart. Journ. Micr. Sci., n.s. vol. xxi. p. 44.
4. O. Butschli.—In Bronn's "Klassen und Ordnungen des Thierreiches." 1880-82, vol. i. (1880) p. 202, pl. v, figs. 5 *a–b*.
5. W. B. Carpenter.—The Microscope and its Revelations. 6th ed., 1881, p. 563 (figs. 320 *g*, *h*.).
6. V. Uhlig.—Ueber einige ober-jurassische Foraminiferen mit agglutinirende Schälen. N. Jahrb. f. Min., etc. (Jahrg. 1882) vol i. p. 152.
7. R. Haeusler.—Notes sur les Foraminifères de la zone à Ammonites transversarius du Canton d'Argovie. Bull. Soc. Vaud. Sci. Nat., 1882, vol. xviii. 88, p. 226.
8. —— Notes on some Upper Jurassic Astrorhizidæ and Lituolidæ. Quart. Journ. Geol. Soc., vol. xxxix. (1883) p. 27.
9. —— Die Astrorhiziden und Lituoliden der Bimammatus-zone. N. Jahrb. f. Min., etc. (Jahrg. 1883) vol. i. p. 60, pl. iv, figs. 9–14.
10. —— On the Jurassic varieties of *Thurammina papillata* Brady. Ann. Mag. Nat. Hist., ser. 5, vol. xi. pp. 262–6, pl. viii.
11. —— Ueber die neue Foraminiferen-gattung Thuramminopsis. N. Jahrb. f. Min., etc. (Jahrg. 1883) vol. ii. p. 68.
12. H. B. Brady.—Report on the Scientific Results of the Voyage of H.M.S. "Challenger" (Zoology) vol. ix. Report on the Foraminifera, 2 vols. (text and plates) London, 1884, pp. 321–4, pl. xxxvi, figs. 7–18, and pl. xxxvii, figs. 1–7.
13. R. Haeusler.—Die Lituoliden-fauna der Aargauischen Impressaschichten. N. Jahrb. f. Min., etc., Appendix vol. iv. 1885, p. 30, pl. iii, fig. 35.
14. J. Wright.—Cretaceous Foraminifera of Keady Hill, Co. Derry. Proc. Belfast Nat. Field Club, 1886. Appendix, 1884–6, p. 329, pl. xxvii, fig. 12.
15. H. B. Brady.—Synopsis of the British Recent Foraminifera. Journ. R. Micr. Soc., 1887, p. 891.
16. R. Haeusler.—Notes on some Foraminifera from the Hauraki Gulf. Trans. N.Z. Institute, vol. xix. 1887 (Wellington, N.Z.).
17. A. Agassiz.—Three Cruises of the "Blake." 1888, vol. ii. p. 164, fig. 496.
18. C. D. Sherborn & F. Chapman.—Additional Note on the Foraminifera of the London Clay. Journ. R. Micr. Soc., 1889, p. 484, pl. xi, fig. 9.
19. F. Dreyer.—Die Pylombildungen in vergleichend-anatomischer und entwicklungsgeschichtlichen Beziehung bei Radiolarien und bei Protisten überhaupt. Jena. Zeitschr. f. Naturw., vol. xxiii. N.F. xvi (1889) p. 111, pl. vi, fig. 94.
20. —— Betrachtungen über den Bau der Rhizopodenschälen. Biol. Centralbl., vol. ix. (1889) p. 341.

21. R. Haeusler.—Monographie der Foraminiferen-fauna der Schweizerischen Transversarius-zone. Abh. Schweiz. Pal. Ges., vol. xvii. (1890) pp. 46 *et seq.*, pls. vi–viii.
22. J. Wright.—Report on the Foraminifera of the South-west of Ireland. Proc. R. Irish Acad., ser. 3, vol. i. (1891) No. 4, p. 468.
23. F. Chapman.—Foraminifera of the Gault of Folkestone. Journ. R. Micr. Soc., 1892, p. 325, pl. vi, fig. 9.
24. R. Haeusler.—Notes sur la distribution des Lituolides dans les Terrains Jurassiques de le Suisse. Mem. Soc. Pal. Suisse, Geneva, vol. xix. (1892) Geneva, 1893, pp. 38, 39.
25. J. G. Egger.—Foraminiferen aus Meeresgrundproben . . . von S. M Sch. Gazelle. Abh. d.k. bayer. Akad. d. Wiss., Kl. II. vol. xviii. pt. 2 (Munich, 1893) p. 71, pl. v, fig. 9.
26. W. Howchin.—A Census of the Fossil Foraminifera of Australia. Austr. Assoc. Adv. Sci., 1893, p. 16. (Reprint.)
27. A. Goes.—Foraminifera of the West Coast of Central America: U.S. Steamer "Albatross." Bull. Mus. Comp. Zool. Harvard, vol. xxix. No. 1, pp. 25, 26, pl. ii, figs. 9, 10.
28. G. H. T. Eimer & C. Fickert.—Die Artbildung und Verwandschaft bei den Foraminiferen. Tübinger Zool. Arbeiten, vol. iii. (1899) No. 6, p. 600.
29. J. G. Egger.—Foraminiferen und Ostracoden aus den Kreidemergeln, der Ober-bayerischen Alpen. Abh. k. bayer. Akad. Wiss. Kl. II. vol. xxi. (1899) pt. 1, p. 15, pl. ii, figs. 14–16, and p. 176, pl. xxv, figs. 51–3.
30. J. M. Flint.—Recent Foraminifera . . . dredged by the U.S. Steamer "Albatross." Rep. U.S. Nat. Mus., 1897 (Washington, D.C., 1899).
31. W. B. Carpenter.—The Microscope and its Revelations. 8th ed. 1901, p. 815, figs. 614 *g*, *h*.
32. F. Chapman.—The Foraminifera. London, 1902, p. 148, pl. viii, fig. A.
33. L. Rhumbler.—Systematische Zusammenstellung der recenten Reticulosa. Arch. f. Protistenk., vol. iii. (1903) pp. 236–7, figs. 65–70.
34. A. Kemna.—Morphologie des Foraminifères arénacés. Ann. Soc. Roy. Zool. et Malac. Belgique, vol. xxxix. (1904) p. 31.
35. F. W. Millett.—Report on the Recent Foraminifera of the Malay Archipelago. Journ. R. Micr. Soc., 1904, p. 608, pl. xi, fig. 7.
36. F. Chapman & W. Howchin.—A Monograph of the Foraminifera of the Permo-Carboniferous Limestones of New South Wales. Mem. Geol. Surv. N.S.W., 1905 (Palæontology) No. 14, p. 9, pl. ii, fig. 13.
37. G. C. Gough.—The Foraminifera of Larne Lough District. Fisheries, Ireland, Sci. Invest., 1905, iii. (1906) p. 4, pl. i, fig. 9.
38. J. A. Cushman.—Monograph of the Foraminifera of the North Pacific Ocean, pt. 1, 1910. Smithsonian Inst., Bull. No. 71, pp. 57–9, figs. 66–72.
39. E. Heron-Allen & A. Earland.—The Foraminifera of the Clare Ireland District, Co. Mayo, Ireland. Proc. Roy. Irish Acad., vol. xxxi. (1913) pt. 64, p. 47, pl. lxiv.
40. J. A. Cushman.—New Textularidæ and other Arenaceous Foraminifera from the Philippine Islands and contiguous waters. Proc. U.S. Nat. Mus., vol. xliv. (1913) p. 637, pl. lxxix, fig. 4.
41. L. Rhumbler.—Die Foraminiferen (Thalamoporen) der Plankton Expedition, pt. 2. Kiel and Leipzig: 1913, p. 361, text-fig. (after Brady) cxviii.
42. E. Heron-Allen & A. Earland.—The Foraminifera of the Kerimba Archipelago, Portuguese East Africa. Trans. Zool. Soc. Lond., vol. xx. (1915) p. 617.
43. —— The Foraminifera of the West Coast of Scotland. Trans. Linn. Soc., vol. xi. (ser. 2, Zoology) 1916, pt. 13, p. 225.

Thurammina

No.	No. of Haul	Station	Locality	Depth in Metres	Nature of Deposit	Typical Sphere = "Orbuline *Lituola*" of Carpenter				
						Chitin	Cement	Grey micaceous	Black	Type
1	8215	viii	61° 30′ N. 3° 3′ E.	375	m. s.	×		×	×	×
2	various	ix	61° 34′ N. 2° 4′ E.	333–370	m. s.	×	×	×	×	×
3	145	ix B	A few miles E. of station ix	330	m. s.	×	×	×	×	×
4	228	..	57° 59′ N. 10° 34′ W.	1600	gl. ooze	×		×	×	×
5	224	..	58° 43′ N. 8° W. ..	448	sand from Spatangus stomachs	×				
6	225	..	58° 43′ N. 9° 6′ W.	1448	gl. o.	×				
7	122	..	59° 25′ N. 7° 4′ W.	1140	gl. o.					×
8	8149	..	59° 25′ N. 7° 33′ W.	1100	s. gl. o.					×
9	36	liii	59° 36′ N. 7° W. ..	1000	s. gl. o.	×		×		×
10	123	..	59° 41′ N. 8° W. ..	850	gl. o.					
11	121	..	60° 6′ N. 6° 31′ W.	1063	gl. o. s. st.	×				×
12	95	xix B	60° 23′ N. 4° 6′ W.	525	c. s. sh.					
13	119	..	60° 34′ N. 4° 32′ W.	965	s. gl. o.	×				×
14	53	xix A	60° 36′ N. 4° 46′ W.	1078	gr. m.					
15	218	xviii A	60° 57′ N. 5° 47′ W.	330	gr. m.	×				
16	221	xiv A	61° 18′ N. 2° 59′ W.	1278	m. s. st.	×		×		×
17	172	xv A	61° 27′ N. 3° 42′ W.	1280	m. s.	×				×
18	199	..	61° 31′ N. 2° 20′ W.	1418	s. o.	×				×
19	?	xv B	61° 39′ N. 4° 45′ W.	253	m. s. sh.	×				×
20	198	xi A	61° 42′ N. 2° W. ..	1236	c. s. o.	×		×		×
21	88	xvi A	61° 49′ N. 5° 36′ W.	205	s. sh.					×

m = mud   sh = shell   st = stones   gl = globigerina *papillata* Brady.

var. *castanea* H.-A. & E.	var. *compressa* Brady	var. *parallela* H.-A. & E.	var. *haeusleri* H.-A. & E.	var. *tuberosa* Haeusler	var. *elegantissima* Haeusler	var. *favosa* Flint	var. *murata* H.-A. & E.	var. *cariosa* Flint	var. *albicans* Brady	var. *sordida* H.-A. & E.	var. *hispida* H.-A. & E.	var. *canaliculata* Haeusler	Remarks
×	×	×	×			×		×		×			
×	×	×	×					×		×		?	
×	×	×	×			×		×	×	×			Chitinous and cement forms predominate
×	×	×	×					×	×	×	×		
×	×		×										All very rare
×			×										All very rare
	×		×										All very rare
			×										Only a few specimens
×	×		×					×		×			*cariosa* frequent, others very rare
			×										Only one seen
×	×		×	×			×		×	×			Very rare
												?	One doubtful specimen seen
×	×	×	×										All rare
			×										Very rare
×			×					×				?	All very rare
×	×		×	×	×		×		×	×			
×	×		×			?	×		×	×			Type and *castanea* frequent, others very rare
×	×		×	×		?			×	×		?	
×	×		×				×	×	×	×		?	All rare
×	×	×	×		×				×	×			*sordida* and *albicans* frequent, *castanea* very fine
			×									?	The best station for the specimens referred to as var. *canaliculata*

s = sand gr = gravel o = ooze c = coarse f = fine

NOTE.

Technical Optics.

The recently established Department of Technical Optics of the Imperial College at South Kensington has now begun its work. It will be remembered that on the initiative of the London County Council a general scheme for providing instruction in this highly important national work was agreed to by the several parties concerned in the early part of the year, when an Advisory Committee to the County Council, representative of the trade, the workers, and other interests concerned, was appointed under the Chairmanship of the Right Hon. A. H. Dyke Acland.

An important part of the scheme was the establishment of the above department, which is administered under the Governors of the College by the same Committee. In June Professor Frederic J. Cheshire was appointed Director of the new department; in July Professor A. E. Conrady was appointed to the Chair of Optical Design, and other subordinate appointments are in hand.

During the summer two Courses of Lectures were given on the designing and computing of telescope systems, and attended by 66 students, of whom 42 came direct from the workshop—a gratifying indication of the recognition by the manufacturers of the importance of this work. About 12 of these were men of academic distinction. The Ministry of Munitions, the National Physical Laboratory, the Royal Observatory, and Woolwich Arsenal were well represented.

This Session well-attended Courses are being given in Optical Designing and Computing, Practical Optical Computing, the Construction, Theory and Use of Optical Measuring Instruments, Theory of the Microscope, and Microscope Technique.

The courses on the Theory of the Microscope and Microscope Technique now in progress constitute the first effort of the Technical Optics Department under the direction of Professor Cheshire to meet the needs of the users of optical instruments. The microscope is perhaps the most important of all optical instruments, and the one for which there is the greatest commercial demand, but unfortunately an exceedingly small proportion of that demand has been satisfied hitherto by English manufacturers. It is hoped therefore in the courses referred to above to excite a wider interest in the designing and production of the microscope, and at the same time to insist upon the necessity for greater technical knowledge and skill in its use.

The course on the Theory of the Microscope is being given by Professor Conrady, and by the courteous permission of Dr. Burrows, the Principal of King's College, the course of lectures on Microscope Technique will be given by Mr. J. E. Barnard, Lecturer on Microscopy at that College.

The question of the organization of consecutive courses of lectures to constitute a complete curriculum for the optical student is under consideration, but it should be pointed out that at the present time the conditions are altogether so abnormal and difficult that any attempt to give a systematized education is not likely to meet with any great measure of success. Paper schemes, whatever their advertising value, would not satisfy those interested in and responsible for the future of English optics. For the present the department must content itself with catering for the wants of existing and available students, not forgetting the urgent importance of work which has an immediate and undoubted war-time value.

OBITUARY.

Robert Braithwaite, M.D. M.R.C.S. F.L.S. F.R.M.S.

May 20, 1824—October 20, 1917.

It is with much regret we have to announce the death of Dr. Braithwaite, in his ninety-fourth year; he was the eldest son of Robert Braithwaite, shipowner, of Ruswarp, near Whitby, where he was born in 1824. He was educated at the Grammar School at Whitby, and afterwards studied medicine, becoming M.R.C.S. in 1858, and M.D. of St. Andrews in 1865. He married the daughter of Dr. N. B. Ward, F.R.S., the inventor of the Wardian Case, and a botanist of repute, who was then practising at Clapham. Dr. Braithwaite succeeded to the practice, which he carried on for many years in Ward's old house, "The Ferns," 303 Clapham Road. His leisure time was devoted to the study of the moss-flora of his country and of Europe generally, and in this subject he became the greatest authority.

He joined this Society in 1866, and served as President in the years 1891 and 1892. Dr. Braithwaite joined the Linnean Society in February, 1863, and was one of the longest-standing members. He served on the Council, 1872–74 and 1889–92, and was a Vice-President, 1889–91.

Dr. Braithwaite was President of the Quekett Microscopical Club in the years 1872–4, having joined the Club in the year of its foundation, 1865.

Dr. Braithwaite's *magnum opus*, "The British Moss Flora," the publication of which was completed in 1905, in three large octavo volumes, constitutes the standard work upon this subject. The 128 plates were all engraved from drawings made by the author, and the whole work forms a remarkable monument of his great skill and industry. In addition, Dr. Braithwaite published a monograph on the peat-mosses, "The Sphagnaceæ, or Peat-mosses of Europe and North America."

His Herbarium of British Mosses, which is authoritative for his work on the moss-flora, was purchased a few years ago by the Trustees of the British Museum, and is available for consultation in the Department of Botany. Dr. Braithwaite's large collection of *separata* relating to the Musci is now in the Library of this Society, in ten volumes, and is indexed in the First Supplement (1910) to the Library Catalogue.

A. W. Sheppard.

SUMMARY OF CURRENT RESEARCHES

RELATING TO

ZOOLOGY AND BOTANY

(PRINCIPALLY INVERTEBRATA AND CRYPTOGAMIA),

MICROSCOPY, ETC.*

ZOOLOGY.

VERTEBRATA.

a. Embryology.†

Development of Stapedial Plate.‡—Frank Pearce Reagan discusses the origin of the plate-like cartilage which forms the distal portion of the stapes. According to some, the entire stapes arises as a chondrification in the second visceral arch. According to others, the stapes arises from the otic capsule. According to a third view, the stapedial plate is formed from the otic capsule, the rest of the stapes from the hyoid arch. And there are other views.

What Reagan has done is to remove from the young chick embryo the auditory sensory epithelium, so as to test to what extent the stapes-homologue, together with its stapedial plate, can develop in the absence of a cartilaginous otic capsule, or in the absence of the stimulus to which the latter owes its origin.

Chick embryos of thirty-five to sixty hours formed the material. One of the otocysts was completely or incompletely removed by insertion into it of a very warm fine-pointed platinum needle, for a sufficient length of time to coagulate the liquid contents of the otocyst, whereupon the sensory epithelium would adhere to the needle when it was removed. Another form of experiment was to transplant an otocyst. The eggs were sealed after treatment and allowed to incubate for various lengths of time.

The results make it highly probable that the stapedial plate owes its formation to the same general stimulus which initiates the cartilage-

* The Society are not intended to be denoted by the editorial "we," and they do not hold themselves responsible for the views of the authors of the papers noted, nor for any claim to novelty or otherwise made by them. The object of this part of the Journal is to present a summary of the papers *as actually published*, and to describe and illustrate Instruments, Apparatus, etc., which are either new or have not been previously described in this country.

† This section includes not only papers relating to Embryology properly so called, but also those dealing with Evolution, Development, Reproduction, and allied subjects.

‡ Journ. Exper. Zool., xxiii. (1917) pp. 85–108 (10 figs.).

formation constituting the otic capsule ; whether the stapedial plate is to be considered a part of the otic capsule, or as an independent formation in the fenestra ovalis, is purely a matter of interpretation. The greater part of the stapedial plate seems to be structurally independent of the otic capsule, while a portion of it is fused with the latter, probably from a very early time, seemingly having arisen from a part of the otic capsule. It seems reasonable to conclude that the avian stapedial plate is not a part of the visceral skeleton. At any rate, if its constituent mesenchyme is a derivative of the second visceral arch, that mesenchyme is powerless to form a stapedial plate unless stimulated to do so by the auditory epithelium.

It is of interest to note that if a very small portion of the otocyst be left in the mesenchyme, the latter will chondrify in the region of the small abandoned sensory epithelium and follow its contour very closely. Whatever may be the configuration of the sensory epithelium, the developing otic capsule always conforms to the shape of the former. It seems well established that the cartilages forming about the three main pairs of sensory epithelia in the head are formed in response to the presence of those epithelia.

The important general result is that the removal of the otocyst from young chick embryos seems entirely to do away with the stimulus to the later development of the otic capsule. Embryos devoid of otic capsules fail to develop stapedial plates. The columellar portion of the stapes attains its full length and normal proportions in the absence of a stapedial plate. The stapes-homologue in birds seems to be of mixed origin, cranial and visceral.

Dependent Development.*—Franklin Pearce Reagan has shown, as above recorded, that the development of the otic capsule and of the stapedial plate belongs to that class of phenomena which have been designated "the interaction of parts," or "dependent development." He briefly discusses these phenomena. Hertwig was one of the first to attach importance to those developmental processes which are due only indirectly to the original constitution of the fertilized ovum, and likewise those due only indirectly to the external environment. These he described as due to the "perpetually changing mutual relations in which cells of an organism are placed to one another." According to Herbst all movements, tropic or tactic, and many processes of differentiation, are responses of a formative, as well as a directive, nature. Thus far the clearly demonstrated cases of interaction of parts are relatively few. Loeb has shown that the position occupied by the pigment-cells on the yolk-sac of *Fundulus* is an oxygenotactic reaction. Several cases have been reported in which early displaced embryonic cells have resumed their original position.

The development of certain parts of the vertebrate eye has been shown to be of a "dependent" sort. Spemann showed that if the formation of the optic vesicle of the frog be inhibited by injury to the medullary plate, or that if its approximation to the ectoderm be prevented, a lens will not form. Lewis showed that ectoderm from other

* Journ. Exper. Zool., xxiii. (1917) pp. 104–6.

regions transplanted to the region approximated by the optic vesicles would give rise to a lens. Werber has shown that numerous isolated lenses may be developed in chemically treated Teleost embryos in the absence of optic vesicles. Spemann and Lewis have shown that the formation of the cornea is a response to stimuli from the optic cup, and will take place even though the lens be removed ; and that the cornea, once formed, degenerates with the removal of the optic cup. Reagan has shown that myocardial concrescence is a tactic response to the presence of endocardial tissue. It is probable that the interaction of parts is of greater importance than is generally recognized.

Microscopic Study of Reproductive System of Fœtal Free-martins.*—Catharine Lines Chapin finds that those organs in the free-martin which are present in the indifferent stage develop towards the male condition (rete, first set of sex-cords, primary albuginea), and those which develop in the normal female at sex-differentiation or later are inhibited from developing (cords of Pflüger, definitive albuginea, union of Müllerian ducts to form uterus). The high degree of variation found in the organs of the reproductive system in free-martins is indicative of the variability of the time at which the interstitial secretion of the male embryo may first be introduced into the circulation of the female embryo, and the amount which may be introduced—in other words, the variability of the time and degree of anastomosis of the extra-embryonal blood-vessels of the two embryos.

The fact that in some free-martins the Wolffian body and Wolffian duct have degenerated more than in a male of corresponding size, though not more than in a female, suggests a later introduction of the secretion of the male, or the introduction of a smaller amount, allowing some development toward the female condition. In one case there was partial union of the horns of the uterus.

The arrangement of cells in the sex-cords of the free-martin as they are arranged in the seminiferous tubules of the male, and the relatively large size of the sex-cord region, suggest an early introduction of the male influence, made before the beginning or early in the process of degeneration of medullary cords which normally takes place in the female, or the introduction of a sufficiently large amount of male secretion to inhibit female development completely, and to cause development towards the male condition. The development of the Müllerian ducts of a 22·5 cm. free-martin into contorted seminal vesicles of small diameter suggests that the male hormone was introduced into the female earlier or in larger amount in this case than in a 28 cm. free-martin, in which the Müllerian ducts were still straight ducts of large diameter.

The Egg-cell and its Development.†—A. Brachet has published the substance of a course of lectures on the egg-cell and the factors in development. He emphasizes the transition from embryological study

* Journ. Exper. Zool., xxiii. (1917) pp. 453–82 (16 figs.).
† L'Œuf et les Facteurs de l'Ontogénèse. A. Brachet. Paris : (1917) 349 pp. (57 figs.).

as an aid to anatomy and cytology to embryological study as a causal analysis of the actual process of development.

Beginning with asexual reproduction and its modes, the author points out that it occurs (especially as proliferation and division) in very favourable nutritive conditions, and also (especially as sporulation and gemmule-forming) in the reverse conditions, of reduced metabolism and depression. There is a synergy or functional interdependence in the organism, in part sustained by hormones; differentiation is the structural side of the division of labour, and implies a certain degree of senescence; there are, as Child has emphasized, dominant correlations and subordinate correlations; there are gradations of metabolic intensity along certain lines. When the strictness of correlations is relaxed or the intensity of the dominant function slackened, a part of the body may recover autonomy in its manifestations, some degree of physiological isolation occurs, the parts in question recover their capacity of all-round metabolism, and thus asexual multiplication becomes possible. The relaxing of correlation may come about in many ways, e.g. by the part being removed by growth to a distance from the centre, or by unfavourable environmental conditions which affect the most differentiated parts most seriously. There is a similar system of correlations in the single cell, but it is a condition of the survival of a part that it should have a nucleus.

Many investigations point to the origin of germ-cells from early blastomeres freed from any share in differentiation, but the cause of the early isolation is unknown. While recognizing that Woodruff and others have by special care extended the asexual multiplication of Ciliata for many years, Brachet holds to the view, suggested by Maupas, that there is a natural limit to asexual multiplication. In this connexion he refers to the interesting case of *Ctenodrilus*, which was observed for fourteen years, and did not exhibit in that period more than asexual multiplication. Eventually Monticelli discovered by accident a large number of sexually mature individuals.

In describing the structure of the ovum (a common diameter in mammals is $\frac{1}{10}$ mm.), the author notes that the term alecithal is never quite accurate, and that while the distinction between nutritive deutoplasm and formative protoplasm is very useful, there are cytoplasmic granulations which it is difficult to classify. Attention is directed to the unique work of Fauré-Fremiet on the ovum of *Ascaris megalocephala*, which traces the chemical linkage between the substances found in the oogonium and those which are elaborated in the oocyte. The histogenesis of the spermatozoon does not begin until the spermatocyte has reached the condition of maturation-equilibrium. There seems to be no exception to the rule that the spermatogonium of the last generation gives rise by two spermatocytic divisions to four spermatids which become four spermatozoa. Along with Henneguy, Prenant, and others, the author declines to accept the view that the chromosomes are permanent and continuous from one cell-generation to another. In regard to maturation, he would distinguish between certainties, such as the numerical reduction of the chromosomes in the course of the maturation of the sex-cells, and conclusions which require further study, such as the longitudinal coupling of chromosomes, and the separation of the couple at the first mitosis.

The maturation-divisions may be accomplished before the liberation of the ova (as in the sea-urchin), or immediately after (as in *Asterias*) : commonest perhaps is that the spermatozoon enters after the ovum has expelled the first polar body and is preparing to form the second. When the spermatozoon enters, a wave of contraction, starting from the upper pole, passes through the ovum ; a small quantity of fluid (perivitelline) is expelled which insinuates itself between the cortex of the cytoplasm and the innermost layer of the egg-membranes. The ovum swims in this liquid, to which water is often added. The second maturation-division then occurs. An active ovum-centrosome is in some cases—e.g. *Mactra*—undoubtedly present ; in other cases—e.g. frog—it is undoubtedly absent, and there may be intermediate conditions.

In connexion with fertilization, Brachet discusses at length the problem of monospermy. Why is it that in most cases only one spermatozoon enters the ovum ? If several enter, as in some Insects, Bryozoa, Selachians, Urodela, Reptiles, Birds, why is it that only one accomplishes fertilization ? The entrance of the first spermatozoon may bring about blocking of the micropyle, but many ova have no micropyle. The contraction of the cytoplasm and the formation of the perivitelline liquid may also prevent polyspermy. Brachet's observations on frog's ova artificially rendered polyspermic (e.g. by using very concentrated seminal material) show the formation of five or so spermatic energids (with nucleus and centrosome and radiations) which are autonomous, repel one another, and rapidly reach a condition of equilibrium. The establishment of the energid renders the cytoplasm refractory to the entrance of another spermatozoon. Very interesting is Rückert's observation that some of the merocytic nuclei which have a transforming action on the yolk of Selachian ova (the others being blastomeric) are heads of accessory spermatozoa. The first spermatozoon to enter is the fertilizing agent, and forms a central energid which repels the others to the periphery. What happens to accessory sperm-nuclei in birds and reptiles is unknown. While energids repel one another the pronuclei attract one another, unless the associated centrosomes counteract this. Three sperm pronuclei may attract one another in a polyspermic ovum.

A ripe ovum passes into a state of "maturation-equilibrium" or inertia, but for a time a slight metabolism—a sort of "agony"—persists. Thus Loeb has proved the occurrence of oxidations. Is the depression of the ovum comparable to that of Infusorians after many divisions ? Is it due to auto-intoxication ? Is it due to "senescence" in Child's sense ? Is there progressive impermeability (Lillie) or osmotic hypertension (Bataillon) ? Experiments point to relative impermeability and paralyzing auto-intoxication.

Although hybridization experiments have proved that the spermatozoon may be the vehicle of generic, specific or varietal peculiarities, Brachet argues that the spermatozoon is but an agent in division, and has not the potentialities necessary for the formation of an organism. He makes a good deal of the subsequently normal development of the embryos of polyspermic frog-ova, and of Godlewski's fertilization of a non-nucleated fragment of *Asterias*-ovum with *Antedon*-sperm, the result being a gastrula with no hint of Crinoid characters. The argument seems to us far from convincing. That the egg-cell with its relatively large amount of cytoplasm enjoys a larger potentiality than the spermatozoon is evident from the facts of artificial pathenogenesis, of which the author gives a very clear account, with special reference to the work of Loeb, Delage and Bataillon.

The mature ovum is a static, the fertilized ovum a dynamic system. Fertilization implies (1) the advent or formation of a centrosome (the *de novo* cytoplasmic origin of a centrosome is accepted as possible); (2) the advent of a half-nucleus, restoring the quantity of chromatin to the normal; (3) the determination of sex, probably as a consequence of (2); (4) the bringing-in of paternal characters; and (5) a number of dynamic manifestations. The essential feature in the formation of a sperm-energid in the ovum is not a centrosome, but a state of the cytoplasm which causes the colloids to coagulate around a centre. There is a brusque change in the surface tension of the cytoplasm.

Of great interest is Herlant's observation, in the polyspermic frog-ovum, that there is a definite relation between the length of a mitotic axis and the nuclear mass to be divided. An over-short mitotic axis may lead to failure in cytoplasmic division, hence the importance of the entrance of the spermatozoon which doubles the volume of the nucleus and ensures the necessary elongation. In regard to the determination of sex, the author concludes that even if the ripe ovum has the sex it will develop into determined by its constitution, the fertilization maintains this or changes this, according as it is effected by one or other category of spermatozoon.

According to the author, the spermatozoon does not share in the "general heredity," the ensemble of causes, factors, laws in virtue of which a fertilized egg gives rise to an individual of a given species, but it may share in the "special or personal heredity" which is concerned with individual parental features. The author's "hérédité" corresponds rather to the English "inheritance": it is the ensemble of all the properties of the fertilized ovum. It finds its entire expression in the physical and chemical qualities of the ovum; but Brachet will have nothing to do with any specific hereditary substances. Yet in explaining the dynamic function of fertilization he has to speak of "formative materials," which, along with the energids, are re-distributed and stabilized in a direction determined by the meridian of the sperm's entrance.

The author's discussion of segmentation is dominated by the conclusion that the germinal localizations existing in the egg are respected in the formation of blastomeres; they are not displaced; they are not added to; they merely become more fixed and stable. The mosaic of the egg-cell is accentuated in segmentation.

But the image of a mosaic is not to be pressed too far. The ovum is not a harlequin's dress with non-interchangeable pieces. It can restore a lost fragment; an isolated blastomere may be as good as a whole; a merotomic fragment may form a complete larva. A quantitative change is not always followed by any serious consequence. In

Ctenophores and Tunicates there is a very strict germinal localization, but they mark one extreme.

Behind deutoplasmic material, with which Brachet includes mitochondria and all that the protoplasm has made, there are probably quantitative regional differences in the protoplasm proper. There are probably zones of different concentration, yet qualitatively uniform, differences of surface tension and capillarity, differences of rate of reaction. Different kinds of eggs may differ in their physical topography, as crystals in their faces and angles.

If a part of an ovum is to serve as the equivalent of a whole, a restoration of the typical topography must first occur, and the proportions of material must be approximately re-established. Does the nucleus during oogenesis influence localization, or do hormones in the parental environment play a part? Or is the topography aboriginal—*the* specific character? The author holds to the idea of the ovum as specifically heterotropic. In the course of development the initial differences between the blastomeres become accentuated and complicated by the different relations established; the specific topography is lost in varying degrees; the "total potentiality" of the cells dwindles as their differentiation becomes accentuated.

Yolk-sac of Pig Embryo.*—H. E. Jordan has made a microscopic study of the yolk-sac of the pig embryo to obtain further data regarding the earliest stages in blood-cell origin and development in mammals. A preliminary report of the work was previously published; the present paper contains full details of more extended observations, and some revised interpretations. The yolk-sac attains its highest stage of progressive histologic differentiation in pig embryos of about 10 mm. in length. This is true both of the endoderm and the angioblast. The endodermal cells are characterized chiefly by abundant presecretion filaments, apparently identical with the cytoplasmic threads found in the cells of the liver and of the mesonephric tubules. Angioblast arises from mesenchyma. The mesothelium of the yolk-sac of pig embryos between 5 and 12 mm. does not produce hæmoblasts, nor is there satisfactory evidence that the mesothelium of the body-stalk and chorion function to this end. The mesenchyma may differentiate directly into endothelium or into hæmoblasts. These last arise extensively at the 10 mm. stage from the endothelium of the yolk-sac blood-vessels. The endothelia of the hepatic sinusoids and mesonephric glomeruli of this stage also show extensive hæmopoietic capacity. Giant-cells, both mono- and polynuclear, are abundantly present in the yolk-sac only at about the 10 mm. stage of development. They may arise from endothelium or directly from hæmoblasts. They are giant hæmoblasts, and apparently function as multiple erythroblasts in which normoblasts differentiate intracellularly. The several stages in hæmopoiesis, represented successively by hæmoblasts, erythroblasts and normoblasts, with transition stages, are abundantly present in the yolk-sac of embryos from 5–15 mm.

* Amer. Journ. Anat., xix. (1916) pp. 277–304 (2 pls.).

Embryonic Circulation in Stickleback.*—R. Anthony has studied the primary circulation in *Gasterosteus gymnurus*. The heart is markedly to the left. The first vessels are the first branchial arches in continuity with the ventricle. A complete circuit is soon formed—heart, first branchial vascular arches, roots of the origin of the dorsal aorta, the aorta, the sub-caudal vein, the anal vein, the sub-intestinal vein, the vitelline vein, the heart. This state of affairs lasts for some hours.

The following complications occur: 1. There is formed a vascular vitelline plexus, at first to the left, then bilateral. It is posteriorly venous; it becomes arterial further forward, being formed by ramifications of the mesenteric artery. 2. Anterior cardinal veins and posterior cardinal veins develop. They form the ducts of Cuvier, at first asymmetrical and to the left, the right one behind the left. 3. The cephalic arteries develop. Symmetry is slowly established.

Anthony points out that the primary asymmetry corresponds closely with that persistent in Amphioxus. It is probable that asymmetry is general in the development of the vascular system in Teleostei. Ryder has noted the displacement of the heart to the *right* in *Apeltes quadracus*.

Gastrulation in Selachians.†—P. Wintrebert has studied this process in the dogfish (*Scyllium canicula*), observing the living ovum and also making sections. The gastrula cavity is produced by a cytulation of a vitelline syncytium; it is situated between the latter and the endodermic-vitelline cells which migrate to the deep surface of the blastoderm. In the first stage the gastrula is peridiscoidal or periblastodermic, largely open to the exterior. In the second stage it is embryonic, localized in the posterior region which will form the embryo; it then takes the form of a vesicle with a narrow blastopore, in most cases a fissure. These two stages are antecedent to what has been called the gastrula, which is a semilunar sub-caudal extra-embryonic space where the gut will be formed later. The author indicates how the peridiscoidal gastrula of Selachians is represented in other types.

Atresia of Œsophagus in Loggerhead Turtle Embryo.‡—H. E. Jordan has studied the atresia of the œsophagus which begins in the embryo of the Loggerhead Turtle (*Caretta caretta*) on the twelfth day, and is a normal developmental condition. During the tenth and eleventh days of incubation the epithelial lining of the oral end of the œsophagus (œsophageo-respiratory primordium) thickens greatly dorsally as a result of extensive cell-proliferation. During the twelfth day the cylindrical tube of the œsophagus becomes compressed dorso-ventrally, thus bringing the dorsal and ventral epithelial walls into close apposition. The apposed central cells fuse and form a plug of tissue, essentially a mesenchyme-like syncytium. By the sixteenth day the atresia has extended into the orifice of the larynx. The chief factor in the temporary closure of the œsophagus is the change in shape from an

* Comptes Rendus, clxv. (1917) pp. 474–6 (2 figs.).
† Comptes Rendus, clxv. (1917) pp. 411–3.
‡ Carnegie Inst. Washington, Publication No. 251 (1917) pp. 345–60 (4 pls.).

approximately circular tube to a structure of wide rectangular form, with at first a slit-like lumen and finally a minute central aperture. The cause of the change in shape lies in the conditions of growth, assisted by the active cell-proliferation in the dorsal wall of the œsophagus. In the sixteen-day embryo vacuoles begin to form in the lining epithelium beyond the oral end, and the process of vacuolization continues until, at the end of the thirty-second day stage, only the extreme oral end of the œsophagus remains closed. The level of initial closure and of final perforation are approximately the same—namely, the laryngeal level of the œsophagus. The temporary atresia of the œsophagus in the *Caretta* embryo would appear to be a device for the protection of the lung during its development against yolk material from the gut. The relatively frequent embryonic and congenital occlusions of the duodenum just caudal to the pancreatic primordia may, the investigator suggests, perhaps likewise find their explanation in terms of a phylogenetic protective device against yolk invasion.

Rate of Regeneration.*—C. Zeleny continues his study of the factors controlling the rate of regeneration. The present paper describes a fresh series of carefully controlled experiments. Frog tadpoles were found more suitable for purposes of experiment than salamander larvæ, which tend to vary in rate of regeneration from day to day, and the factor to which this fluctuation was due was not discovered. The first series of experiments is directed towards comparing the rate of regeneration from old tissue with that from new tissue. The whole of the data are given in tabular form. There was little difference in rate between the two; the slight difference is in favour of the cut through newly regenerated cells, but it may not be significant. As regards completeness of regeneration there was again essential similarity between the old tissue and the new tissue levels. It would therefore appear that the rate of regeneration is controlled in large part by factors not inherent in the character or conditions of the cells near the cut surface. In the case of the earliest stages, those in which there is cell migration but no cell division, there is some evidence that the rate of regeneration may be greater from new than from old tissue.

The second series of experiments dealt with the effect of successive removals upon the rate and completeness of regeneration. In experiments in which the age factor was eliminated the second regeneration had the advantage over the first, and the third over the second, both in respect of rate and of completeness. In experiments in which the age factor was not eliminated the time intervals varied somewhat in each set, but there was evidently a decrease in rate from the first to the third and fourth regeneration. The decrease is probably due to increase in age, not to successive removals.

In regard to the level of cut it was found as a general rule that the length regenerated in a given time is proportional to the length removed, or, in other words, the length regenerated per unit of removed length is a constant. This, however, applies only to material produced

* Illinois Biolog. Memoirs, iii. (1916) pp. 1–169.

by active cell-division. It does not seem probable that the differences in length at different levels can be due to differences in the character of the cells involved. The process must be under a more central control, probably connected with general functional activity. The changes in rate during the regenerative process bear a definite relation to the histological processes observed. The rate of regeneration of one limb, e.g. the right foreleg, is greater than when the other foreleg is removed at the same time, but when a dissimilar organ, e.g. the tail, was injured at the same time the rate was not altered. Incompleteness of regeneration is of frequent occurrence. "The factors at work in bringing regeneration to a close tend to overdo rather than underdo their functions."

b. Histology.

Spleen During Hibernation.*—Frank C. Mann and Della Drips have made observations on *Spermophilus tridecemlineatus* during hibernation. Grossly and microscopically the spleen becomes intensely congested. The maximum is reached within a few days after the animal becomes torpid, and this is retained for about forty days. After seventy-five days of torpidity the amount of blood in the spleen is not greatly in excess of that found in the organ of active animals. There are changes during hibernation in the number of phagocytic endothelial cells containing red blood corpuscles or blood pigment. The intense congestion of the hibernating spleen is probably due to a loss of tone and relaxation of the intrinsic muscles of both the spleen and the blood vessels. Perhaps the spleen acts as a store for red blood cells in the early stages of hibernation, and allows them to be added to the circulation as needed.

The Cell Aster.†—R. Chambers publishes the second of his micro-dissection studies—the cell-aster, a reversible gelation phenomenon. Marine eggs, the development of which could be easily followed, were used, and most of the conclusions relate to *Echinarachnius* and *Cerebratulus*. He finds that the sphere is a liquid region free of granules, occupying the centre of the aster, and increasing steadily in size until the aster reaches full development. The increase in size is apparently due to the accumulation of liquid flowing into the sphere from all parts of the cytoplasm. The aster rays appear to be the channels in which the centripetal flow occurs. The cytoplasm between the rays is in the gel state, to which the rigidity of the aster is due. The gel state is most pronounced near the sphere, and, peripherally, passes gradually in the sol state of the cytoplasm lying beyond the confines of the aster. When the aster reaches the periphery of the cell the entire cell is rendered comparatively rigid. In the maturation figures of the egg-nucleus the peripheral aster forms a continuous gel with the surface layer of the egg to which the figure is thus firmly attached. The confines of the central aster pass insensibly into the

* Journ. Exper. Zool., xxiii. (1917) pp. 277-84 (4 figs.).
† Journ. Exper. Zool., xxiii. (1917) pp. 483-506 (1 pl.).

surrounding liquid cytoplasm. A periodic reversal of the sol to the gel state, and *vice versa*, has been demonstrated in the cell protoplasm during division. The process may be described as follows: When the aster is fully formed the greater part of the cell is a gel. The cytoplasm reverses to a sol state, and the astral radiations fade out while the sphere liquid collects at the two poles of the nucleus. The formation of radiations about the spheres at each pole of the nucleus producing the amphiaster is accompanied by a return to the gel state. A return to the sol state takes place in the equator of the cell. The nuclear spindle now divides, a constriction around the middle of the cell then follows, and continues until the cell is cut in two. As a general rule the reversal of the gel to the sol state starts in the equator of the cell and spreads to the poles. On the other hand, the reversal of the sol to the gel state commences about the sphere and spreads towards the periphery.

The gel state in living protoplasm is not inert. Even to the eye there is a constant but very gradual change among the granules embedded in the cytoplasmic gel. There are appreciable differences in the liquid state of the cytoplasm in certain regions and at various times; for instance, the interior cytoplasm of the unfertilized and fertilized egg before the aster is formed is slightly viscous, whereas the contents of the sphere and of the rays, and also of the hyaline area in the vicinity of the forming polar body, are very fluid. The aster in its early stage can be made to disappear by churning its contents with a needle. This causes a reversal of the gel to the sol state. From a study of cell-division in the eggs of *Echinarachnius*, *Cerebratulus*, *Arbacia* and *Asterias*, the investigator concludes that one of the factors concerned lies in a peculiar colloidal property of protoplasm, namely, a periodic reversibility in its sol and gel states.

Photomechanical Changes in Retina of Normal and Transplanted Eyes of Amblystoma Larvæ.*—Henry Laurens and J. W. Williams have studied the effects of light and darkness on transplanted eyes with reference to the question whether the photomechanical changes can take place independently of the central nervous system. The authors' method is free from certain objections that might be raised against arguing from cases where the optic nerve has been cut, which involves shock and degeneration. The transplanted eye has never been under nervous control. The results of the experiment show that pigment migration and cone contraction take place in the transplanted eyes as well as in normal eyes, and to a greater extent.

Melanophores of Amblystoma Larvæ.†—Henry Laurens finds that the melanophores of the larvæ of *A. tigrinum* behave like those observed in *A. punctatum* and *A. opacum*; they expand in light and contract in darkness in both seeing and eyeless larvæ. The melanophores of seeing larvæ that have been kept for some time (four days or more) in bright diffuse light over an indifferent bottom are, however, partly contracted

* Journ. Exper. Zool., xxiii. (1917) pp. 71–82 (1 pl. and 3 figs.).
† Journ. Exper. Zool., xxiii. (1917) pp. 195–205 (6 figs.).

($\frac{1}{8}$ to $\frac{1}{4}$ expansion), while the melanophores of seeing larvæ that have been kept for some time in darkness (more than five days) are expanded ($\frac{3}{4}$ to $\frac{7}{8}$ expansion), thus showing, under long-continued illumination and darkness, what has been called a secondary reaction.

Chromatophores of Brook Trout.*—John N. Lowe has subjected the chromatophores of *Salvelinus fontinalis* to various chemical agents. The young stages have only one kind of pigment cell, the melanophore; from two to fourteen days they do not react to background; this occurs after the yolk is absorbed. In the presence of oxygen, the pigment cells remain expanded; when hydrogen is substituted the pigment cells contract, and the embryos die. Carbon-dioxide causes contraction. Boiled or distilled water causes contraction. In the potassium salts there is rapid contraction; in the neutral salts of sodium there is slow contraction. The influence of alcohol, strychnine, morphine, nicotin, and other agents is recorded.

Scales of Spring Salmon.†—C. McLean Fraser has made a microscopic study of the scales of the Pacific salmon, *Oncorhynchus tschawytscha*. The growth of the scale is a reliable indication of the growth of the fish. Annual bands of growth appear on the scale, each consisting of a wide portion with the lines on it somewhat distant, and a narrow portion with the lines closer together. The narrow band may be called the "winter check" appropriately, because, although the retardation of growth is due to lack of food rather than to a lowering of the temperature, it is produced in the winter months, January, February and March, with indications of it in December and April.

There are two types of scales, since some of the salmon migrate to the sea as fry and have no fresh-water record on their scales, while others migrate as yearlings or fingerlings after having a year of comparatively slow growth in the fresh-waters clearly indicated on their scales.

The majority of both types mature in their fourth or fifth years. Probably a greater percentage of the "sea-type" than of the "stream-type" mature in the fourth year, but a majority of the whole number are of the "sea-type." The fish that mature in the fourth year are, as a rule, among the larger of the year-class. Probably if enough third-year grilse were examined there would be proof that they are among the largest of the year-class.

The "sea-type" fish has a decided advantage throughout life, both in length and in weight, so much so that an average fish of the "stream-type," mature in the fifth year, is scarcely larger than a "sea-type" fish mature in the fourth year. If they are both in the same year when mature, either the fourth or fifth, there is an average difference of six or seven pounds. Unless there is some other preponderating reason for keeping spring salmon in rearing ponds for a year, it is decidedly unwise to do so, as, taking it either in size or in time, there must be a difference of at least 20 or 25 p.c. in favour of the "sea-type" fish.

* Journ. Exper. Zool., xxiii. (1917) pp. 147–93 (1 pl. and 3 figs.).
† Contributions to Canadian Biology, 1917, pp. 11–32 (15 figs.).

c. General.

Evolution Theory in the Light of Genetics.*—C. B. Davenport discusses "the form of evolutionary theory that modern genetical research seems to favour." His conclusion is that "a theory of evolution that assumes internal changes chiefly independent of external conditions, i.e. spontaneously arising, and which proceeds chiefly by a splitting up of and loss of genes from a primitively complex molecular condition of the germ plasm seems best to meet the present state of our knowledge."

Such a theory receives support from various fields:—(1) From ontogeny, where the differentiated end stage is derived from a relatively undifferentiated, but probably molecularly complex egg; (2) from palæontology, where the history of the phylum seems to be governed by internal laws; (3) from experimental breeding, where progress is afforded only as internal changes permit; and (4) from analogy with evolution in the inorganic world, so far as may be inferred from studies on the "rare earths."

"Such a theory makes clear that success in 'selection' depends on rate and amplitude of internal change and ability to judge of germinal from somatic conditions. It renders less hopeful (but not hopeless) the prospect of being able to control completely by experimental methods evolutionary change."

Pineal Gland and Pigmentation.†—Carey Pratt McCord and Floyd P. Allen have studied the influence of pineal gland substance upon pigmentation in tadpoles. It has been suggested that the changes in pigmentation exhibited by blinded animals when placed in new environment may be due to some ocular function exerted by the pineal body. Laurens has shown that this is very unlikely. But the authors' experiments, while not supporting the view that the pineal body may act in the rôle of its ancient ocular function, show that it contains within itself an active principle capable of inducing pigment changes independent of and wholly apart from environmental conditions. Indeed the changes in pigmentation induced by pineal feeding appear in spite of environmental conditions tending towards the opposite phase.

Up to near the tenth day of larval life in tadpoles, pigmentation is not influenced by pineal feeding, which may be due to incomplete development of the innervation involved.

From about the tenth day until near the termination of metamorphosis, the addition of traces as small as 1 part acetone extract in 100,000 parts water determines distinct cyclic pigment changes. The pineal feeding is rapidly followed by loss of colour. Within thirty minutes all macroscopic pigment is lost. The condition is transient, and there is restoration of colour within three to six hours, unless further pineal food is added. As metamorphosis is completed the pigment is no longer altered by pineal materials.

* Amer. Nat., l. (1916) pp. 449–65.
† Journ. Exper. Zool., xxii. (1917) pp. 207–24 (7 figs.).

The pineal substance responsible for the pigment changes is wholly extracted by acetone. The residue after acetone extraction is an inert substance as far as influencing pigment is concerned. But this residue influences growth and differentiation. The inference is that the gland contains more than one active substance.

The reactions produced by pineal extracts add some evidence to Spaeth's contention that the melanophores are modified smooth muscle-cells. The similarity of contraction of certain smooth muscle organs under the influence of pineal extracts, and the contraction of melanophores is in keeping with Spaeth's hypothesis. The very nature of the pineal-pigment cycle affords an excellent method of approach to the study of melanophore function and to the larger problems of the colloidal state.

Reactions of Tadpoles to Light.*—William H. Cole and Carleton F. Dean have studied the photokinetic reactions of tadpoles, probably of *Rana clamitans.* They showed themselves sensitive to light when a length of 40 mm. or more is reached. The skin is the important receptor for photic stimulation, the tail region being the most sensitive. The reaction varies with the age or stage of development; the youngest stages being indifferent, the mid-larval stages being photokinetic, and the final stages being positively phototropic. Previous exposure to illumination or darkness has very little influence on the intensity of the reaction. It is probable that the reaction is controlled by a nervous nexus, and not by direct stimulation of the melanophores.

Colour-changes of Reef-Fishes.†— W. H. Longley has spent several years studying the colours and colour-changes of the West Indian reef fishes with a view to throwing fresh light on the general problem of the biological significance of animal coloration. The reef fishes are peculiarly suited for such a study. They are richly coloured; many species may be observed in a single circumscribed area; they possess as a class a great power of colour-change; they can be studied in their natural environment; and it is usually possible to determine the nature of their food by analyzing the contents of the stomach. Countershading—the definite gradation of pigment from darkest on the mid-dorsal to lightest on the mid-ventral line—appears almost universally on reef fishes, and its absence or relative deficiency seems to be definitely correlated with some unusual habit or peculiar form. Colour-changes, which occur even among the most gaudy, tend to assimilate them to their environment, and in general their colours repeat those of their surroundings. Specially-defended types are not unlike others in pigmentation, or inferior to them in their ability to effect adaptive colour adjustments. Finally, there is no evidence that brightly-coloured species enjoy greater immunity from attack than others, for they constitute a large proportion of the food, and may be readily identified in the stomach contents of predaceous forms. These statements, which rest on a great body of verifiable observations, are consistent with the

* Journ. Exper. Zool., xxiii. (1917) pp. 361–70.
† Journ. Exper. Zool., xxiii. (1917) pp. 533–601 (1 pl.).

Darwinian hypothesis, but are inconsistent with the assumption that brightly-coloured animals possess more than minimal conspicuousness under natural conditions. They impel one to reject the hypotheses of warning and immunity coloration, signal and recognition marks, and sexual selection, at least in so far as they may ever have been supposed to apply to these forms. On the other hand, they confirm Thayer's conclusions regarding the obliterative function of colour and pattern, emphasize the common occurrence of adaptive characters among animals, and suggest that their evolution has been guided throughout by natural selection.

Abnormality in Arterial System of Rabbit.*—Edmond J. Sheehy describes a case in which the innominate artery gives off the two carotids, but does not give rise to the right subclavian. A blood-vessel, serving as a right subclavian—that is, supplying the right vertebral and the arteries of the right arm—arises from the descending aorta dorsally and slightly caudal to the left subclavian. It passes dorsal to the heart and œsophagus, and appears on the right side in its proper position in the vicinity of the first rib. The arrangement of the nerves is normal. Abnormalities of a similar nature in the human subject have been described and attributed to a persistence of embryological conditions. The author explains this.

Pectoral Girdle of Tetrapod Vertebrates.†—L. Vialleton has made an interesting comparative study of the pectoral girdle in Amphibians, Reptiles, Birds, Monotremes, and Eutheria.

Striped Haddock in New Brunswick.‡—E. E. Prince describes interesting striped specimens of the common haddock (*Gadus æglefinus*). They exhibit a series of broad bands and blotches of dark pigment on each side of the body from the shoulder to the tail. Professor McIntosh has pointed out that the minute larval cod is marked by a series of transverse bars; but the larval haddock is not. The black stripes disappear on the adult cod; a vestige persists in the haddock as the "thumb-mark." Such blotches when repeated serially must be regarded as atavistic, a reappearance of an ancestral trait or feature, which in most specimens has practically disappeared.

INVERTEBRATA.

Mollusca.

α. Cephalopoda.

Notes on Cephalopods.§—Madoka Sasaki describes the first specimen determined to be a male of the rare species, *Amphitretus pelagicus* Hoyle, a jellyfish-like Octopod. He regards it as nearer to Polypidæ than to *Cirroteuthis*. Four new species of *Polypus* are described.

* Sci. Proc. R. Dublin Soc., xv. (1916) pp. 159–62 (3 figs.).
† Bull. Acad. Sci. Montpellier, 1917, pp. 170–214.
‡ Contributions Canadian Biol., 1917, pp. 86–90 (1 pl.).
§ Annot. Zool. Japon., ix. (1917) pp. 361–7 (2 figs.).

Sepia officinalis.*—L. Cuénot discusses the species *Sepia officinalis* L., which seems at first sight very homogeneous and constant. It is in reality a species in process of dissociation. Four forms may be distinguished —*filliouxi* Lapont, *fischeri* Lapont, *officinalis*, and *veranyi* P. Fischer, which are incipient or nascent species. They differ from one another (1) in the time at which they leave the medium depths of the ocean to enter the waters of less depth and less salinity; (2) in the time of sexual maturity and oviposition; and (3) in minute features of form, such as the structure of the sepiostaire.

γ. Gastropoda.

Gymnosomatous Pteropods of Coasts of Ireland.†—Annie L. Massey reports on a collection of these minute animals from the west, south, and east coasts of Ireland. To distinguish nearly allied species it is often necessary to dissect out the buccal parts and prepare the radula and hook-sacs. Of the twelve species dealt with six appear to be new to science, and four have not previously been recorded from British and Irish seas. The only form abundant enough to be of value as fish food is *Pneumodermopsis paucidens* (Boas), which resorts chiefly to shallow water. A key is given for the identification of British and Irish Gymnosomata. The new species are :—*Pneumodermopsis oligocotyla*, *Spongeobranchæa polycotyla*, *Clionopsis longecirrata*, *Cephalobrachia bonnevii*, *Thliptodon atlanticus*, and *T. rotundatus*.

Sex-cycle in Crepidula.‡—Harley N. Gould has studied the sexual cycle of *Crepidula plana*, which lives attached to the inside of the Gasteropod shell occupied by the large hermit-crab, *Eupagurus bernhardus*. It is a protandric hermaphrodite, with the male and female phases completely separated. The assumption of the male condition does not always occur at the same stage in the life-history, with respect to age or size; and there is reason to believe that the male phase is sometimes entirely omitted. The growth of the animal during the first part of its life, i.e. during the period in which male development may occur, is very variable, and depends in part upon (1) the amount of movement of the animal; (2) the amount of space available for the extension of the mantle; and (3) the season of the year.

Primordial male and primordial female cells are both present in the gonad at the periods from the post-larval up to the adult female phase, and are visibly different from each other. As in other protobranchs there are atypical as well as true spermatozoa. The former are of the "apyrene" variety. They develop from cells which cannot at present be distinguished from spermatogonia. After the cells, which are to form apyrene spermatozoa, are differentiated, there are no maturation or other divisions.

During the change from the male to the female condition part of the testicular cells complete their development and are passed into the

* Arch. Zool. Expér., lvi. (1917) pp. 315–46.
† Sci. Proc. R. Dublin Soc., xv. (1917) pp. 223–44 (1 pl.).
‡ Journ. Exper. Zool., xxiii. (1917) pp. 1–69 (85 figs.).

seminal vesicles as adult spermatozoa. The rest are absorbed into the wall of the testis, where they are dissolved ; or else they degenerate in the lumen of the gonad. There is a temporary reduction in the size of the gonad ; it becomes large again when the oogonial cells, after a period of division, develop into oocytes and enter upon the growth period.

The goniduct serves for the transference of both spermatozoa and eggs, but is, structurally, entirely different in the male and the female phases. In the male phase it is differentiated into seminal vesicle and vas deferens.

The accessory male organs appear only when the testis develops. In the "sexually inactive" animals there is no penis, seminal vesicle, nor sperm groove. These develop very quickly, however, when male differentiation takes place in the gonad.

During the change from the male to the female condition, or upon the premature loss of the male condition, the penis, seminal vesicle, and sperm groove degenerate. Before its degeneration the seminal vesicle absorbs the contained spermatozoa into its wall, where they dissolve.

As the female phase is gradually assumed the goniduct increases greatly in size, acquires longitudinal folds and glands in its wall, and becomes the oviduct. At this point in the life-history the "gono-pericardial duct" is also developed, connecting the pericardial chamber with the oviduct.

Influence of Environment on Sex of Crepidula.*—Harley N. Gould finds that in the protandric hermaphrodite *Crepidula plana* the development of the male phase is dependent upon the presence of a larger individual, not necessarily a female, of the same species. Some stimulus passes from the larger to the smaller. A small stimulus will initiate the male development, but a greater one is needed to complete and maintain it. When a male is removed from the neighbourhood of the larger animal, the male organs degenerate, a condition of sexual inactivity ensues, later replaced by female development.

If a larval *C. plana* settles and grows during the first part of its life where no larger individuals are present, the male phase probably never occurs ; but if at any time up to the female stage the small individual comes within the sphere of influence of a larger one, it will immediately develop male organs, attaining the male condition in about two weeks. Whether or not the male phase is realized, the female phase is eventually developed.

The degeneration of the male organs does not prevent a second or third male development if the small individual comes within the sphere of influence of a larger one after the degeneration. Partial degeneration may be stopped and male activity resumed.

During the male phase the growth of the body is retarded ; after degeneration of the testis and during the sexually inactive condition, or in neuter animals which have never developed the male condition, growth is rapid.

The first steps of female development may be interrupted and replaced by male development, under experimental conditions. In this

* Journ. Exper. Zool., xxiii. (1917) pp. 225-50.

case the oocytes degenerate, and the activity of the primordial female cells is suspended; the primordial male cells multiply and undergo maturation. After the oocytes are advanced in the growth period, male development is no longer possible.

The nature of the stimulus to male development remains unknown. 1. It depends upon the presence of the actual body of a large individual. 2. The movement of the smaller individuals, from whatever cause, does not furnish the stimulus, for some males are developed while in the fixed position. 3. Male development does not depend upon the amount of food received; for starved neuter specimens develop a testis as quickly as well-fed ones, when in the presence of large females; and they do not develop any more quickly. 4. No experiment has so far demonstrated the existence of a stimulating secretion, but this possibility has not been thoroughly tested. 5. The stimulus does not depend upon the presence of the hermit-crab with which the molluscs are associated; it will have its effect even if the home of the colony is a finger-bowl.

Whatever the manner of working, the adaptation is advantageous. For it provides that the male members of every colony shall quickly develop into females as soon as there is no longer a larger female which requires fertilization; and also that there shall be adult males in the colony ready to function as soon as any individual has reached the adult female phase.

Arthropoda.

a. Insecta.

Effect of X-rays on Length of Life of Flour Weevils.*—Wheeler P. Davy has experimented with the beetle *Tribolium confusum*, which does much harm to cereal stuffs. It was found possible to destroy the eggs of the beetle by using X-rays, and careful exclusion showed that the lethal effect was due to the X-rays only, and not to some accidental circumstance.

Circulation of Blood in Insects.†—F. Brocher has made an experimental study of the circulation of the blood in insects, using chiefly fully developed specimens of *Dyticus marginalis* and two species of Odonate larvæ. Most of the conclusions reached in this paper refer to *D. marginalis*, and the experiments were especially directed towards determining the function of the dorsal blood-vessel. The structure of the vessel is not described in detail, but on two points the author differs from Oberlé; he finds only seven pairs of ostia, not eight, and he does not accept Oberlé's statement that the dorsal vessel terminates posteriorly in a *cul-de-sac*. The experiments showed that when *Dyticus* is in a state of repose, as under an anæsthetic, the blood contained in its abdomen is subjected to negative, not positive, pressure. This negative pressure results from the action of the dorsal blood-vessel which, pulsating continually, attracts to itself the liquid in the abdominal cavity. In the dilated posterior portion of the vessel this inspiratory

* Journ. Exper. Zool., xxii. (1917) pp. 573–92 (5 figs.).
† Arch. Zool. Expér., lvi. (1917) pp. 347–58.

action reaches its maximum. The posterior extremity of the dorsal blood-vessel (in *D. marginalis* and *D. punctulatus* at least) has a slightly elongated form, and terminates in two lips, which function as a double valve. At each systole the lips open under the pressure of the blood, which then escapes; at each diastole they close again passively and the blood cannot enter. In regard to the rôle of the aliform muscles the investigator agrees with Popovici that they simply maintain the subcardiac diaphragm at a certain degree of tension, but that they do not, as is commonly supposed, actually produce the diastole by contracting the lateral walls of the dorsal blood-vessel. The transverse currents found by Newport and Blanchard were made out. They occupy free spaces among the organs and are produced by the inhalent pulsations of the dorsal vessel, and directed towards the ostia by which they can penetrate into it. The dorsal blood-vessel then is not merely an organ of propulsion but functions also, and probably more strongly, as an inhalent pump, and the centripetal circulation of the blood in the body results from the fact that the dorsal blood-vessel tends to draw to itself the fluid in the abdominal cavity.

Minute Changes in Metamorphosis.*—E. Bordage finds that in many metabolic insects of diverse orders the larval tissues become in great part reserve tissues, with fats and albuminoids. Ferments are probably at work, coming from the fatty bodies or from the imaginal disks. Syncytial masses appear or separate trophocytes. Some of the material is used up; some passes into the imago. Besides the transformation of tissue, there is sometimes a simpler histolysis. Phagocytosis occurs in Muscidæ, but not in other cases until after the formation of the pupa. Its importance has been much exaggerated.

In the metamorphosis of *Calliphora*, a longitudinal section of the larva, when it is about to become quiescent, shows that the fatty body is represented by two long narrow bands. But the pupa contains an enormous number of trophocytes. Yet it is recognized that the adipose cells of Muscidæ do not divide. Therefore the crowds of trophocytes which have made their appearance must be due to a transformation of other larval tissues. It was this observation that led Bordage to a recognition of a general occurrence of cellular transformation in metamorphosis.

French Mosquitoes and Paludism.†—E. Roubaud has experimented in order to find out whether mosquitoes in the Paris region are refractory to the malaria organism. He worked with *Plasmodium vivax* Gr. and Fel. (var. *tertiana* Lav.) and *Pl. præcox* Gr. and Fel. (var. *parva* Lav.), and found that Parisian specimens of *Anopheles maculipennis* are quite able to transmit the disease, and do not form a refractory race. Precautions should be taken. In an appended note A. Laveran emphasizes the reality of the danger in view of the number of soldiers in the country who have been infected with malaria, and indicates that practical measures to prevent diffusion have been in operation.

* Comptes Rendus, clxv. (1917) pp. 477–9.
† Comptes Rendus, clxv. (1917) pp. 401–4.

Head-capsule and Mouth-parts of Diptera.*—Alvah Peterson has made an elaborate study of the sclerites of the fixed and movable parts of the head in one or more representatives of fifty-three of the fifty-nine families of North American Diptera. There are more than 600 figures. The chief diversities are due to reduction, change of shape, loss of chitinization, or expansion of the membranous areas. One of the most important conclusions concerning the generalized head-capsule relates to the position of the epicranial suture. The stem of this suture along the dorsal median line represents the line of fusion of the paired sclerites of the head, while the arms of the suture ventral to the antennal fossæ enclose the unpaired sclerites of the head. In all but one or two genera the frons and clypeus form a continuous fronto-clypeus. The labrum is distinct from and ventral to the fronto-clypeus; it is joined to the epipharynx.

The tormæ are chitinized lateral pieces of the epipharynx which project anteriorly and unite with the fronto-clypeus in generalized Diptera. They are also present in such generalized insects as the Orthoptera. In the more specialized Diptera the tormæ are interpolated between the fronto-clypeus and the labrum, and in all but a few genera lose all connexion with the chitinized portions of the fronto-clypeus. Their exposed surface is best seen from a cephalic view.

The crescent-shaped frontal suture dorsal to the antennal fossa marks the line of invagination of the ptilinum, the origin of which has not been determined. The vertex is the paired continuous area on the cephalic aspect of the head, and the region of the vertex ventral and median to each compound eye is a gena.

The compound eyes show secondary sex-characters in a greater number of species than do any other of the fixed and movable parts. The three ocelli form a triangle. A description is given of the occiput, the postgenæ, the tentorium and its invaginations.

The evolution of antennæ is traced from a generalized filiform type to that found among the Cyclorrhapha. Only a few generalized Diptera have mandibles. These are confined to the females, except in *Simulium*, where they are well-developed in both sexes. All Diptera having functional mouth-parts have maxillæ; there are no palpigers, the cardines and stipites are fused to the head capsule; the maxillæ show considerable diversity, and are reduced to a mere ental rod and a palpus in the Calyptratæ.

The labium shows considerable diversity, due to reduction and membranous development. Palpigers and labial palps are always wanting. The submentum and mentum are represented by a membranous area of the posterior surface of the head. The basal part of the ligula usually gives rise to two large bulb-like paraglossæ and to glossæ situated between them. The paraglossæ are specialized, and have chitinized areas on their lateral and caudal surfaces and pseudotracheæ on their mesial surface. Epipharynx and hypopharynx are very uniform. The proboscis of the Cyclorrhapha is composed of the labium, maxillæ, hypopharynx, labrum-epipharynx, and tormæ. The paraglossæ of the labium form the distal labellæ. The mouth-parts of

* Illinois Biol. Monographs, iii. (1916) pp. 1–112 (25 pls.).

Oneodes and *Gastrophilus* are not functional, and are so greatly reduced that it is difficult to homologize their parts.

Relation of Bacteria and Yeasts to Development of Mosquito Eggs.*—E. E. Atkin and A. Bacot have studied the relation between the eggs and the development of the larvæ of *Stegomyia fasciata* (*Aedes calopus*) and the presence of bacteria and yeasts. The result of the experiments on eggs is so far clear and decisive in regard to the fact that the presence of bacteria, yeasts, and, less definitely, moulds, does exert a stimulus causing eggs to hatch that would, apart from their presence, have remained dormant for a longer period. It also seems definite that this stimulus is less powerful, or may be altogether ineffective, if killed cultures or sterile filtration and extracts of bacteria or yeast are used. The difference is apparently one of quantity, not quality, its extent being chiefly dependent upon some variation in the susceptibility of the eggs.

The larvæ greedily consume both bacteria and yeasts, on which they can thrive in the absence of any other food, whereas in very many instances they fail entirely to develop on a variety of nutritive fluids and particles, including dead bacteria, under sterile conditions. In the far less numerous cases, where progress was made under apparently sterile conditions, growth was always relatively very slow compared with that under otherwise equivalent but unsterile conditions, and the mortality was very high. It may be said that the presence of bacteria or yeast is a practical necessity for the maintaining of the species. Bacteria and yeasts afford the chief food supply. The ingestion of larger particles and the structure of the jaws need not be regarded as incompatible with this view, because such particles are likely to be covered with a bacterial growth, while the jaws are of use in gnawing away portions of decaying organic matter. This knowledge may be of assistance in the destruction of this species of mosquito, as it should enable the methods now so largely available for the purification of water from bacteria to be utilized.

New Genera of Nycteribiidæ.†—Hugh Scott discusses a number of points connected with these highly modified and wingless Diptera, external parasites of bats, which are included in a probably polyphyletic group, "Pupipara." The components differ widely among themselves, but all have the characteristic of retaining the young within the body of the parent till the larval life is practically completed, and of then giving birth to the matured larva, which almost immediately commences its transition into the pupal stage. Scott describes *Eremoctenia* g.n. with no thoracic ctenidium. All other Nycteribiidæ have thoracic and abdominal ctenidia, except *Archinycteribia* Speiser, which has no abdominal ctenidium. Another new genus is the blind *Tripselia*, and a new subgenus *Paracyclopodia* is erected within *Cyclopodia*. There is a fine drawing of *Eremoctenia*.

* Parasitology, ix. (1917) pp. 482–536.
† Parasitology, ix. (1917) pp. 593–610.

Colour-pattern of Wings of Diptera.* — Professor J. F. van Bemmelen has studied this in species of *Hæmatopoda*, *Pœcilostola*, *Sciomyza*, *Traginops*, *Tephritis*, and other genera, and finds confirmation of his view that there is a regular and simple but complete original colour-design common to all Diptera. It is possible to find a connexion between patterns of widely different appearance; to derive one pattern from another; to find along different lines of evolution a recurrence of the same sequence of patterns. As in Hepialids, "the motives and patterns of the colour-design are older than the genera and families which display them."

Effects of Light on Rate of Locomotion in Vanessa antiope.† — W. L. Dolley has made experiments to test the effects of intermittent light and continuous light of different illuminations on the rate of movement in *V. antiope*, with special reference to Loeb's "continuous action theory" of orientation. The experiments did not bear out Loeb's theory, for the butterfly did not move faster in strong light than in weak, but rather moved faster in weak than in strong light if the difference in degree of illumination was sufficiently great. This corroborates the conclusions reached by the author in an earlier paper. In intermittent light of a frequency of interruption of ten and sixteen per second *Vanessa* moves faster than it does in continuous light. This supports the contention that in this butterfly orientation in light is due to the time rate of change of intensity.

Setal Pattern of Caterpillars.‡—A. Schierbeek continues his study of the arrangement of bristles and homologous structures in caterpillars. He showed that the abdominal pattern was more primitive than the thoracic, that a primitive type and three derivative types could be distinguished, that stripes were evolved later than spots, and so on.

He goes on to express his agreement with Boas as to the metathoracic stigma having moved forward on to the intersegmental membrane between meta- and mesothorax, and as to the so-called prothoracic stigma being really that of the mesothorax. In accordance with Poulton and Spuler, he has been able to trace an eleventh abdominal segment in certain caterpillars during their first instar, as in *Hepialus hecta*, *Phalera bucephala*, *Sphinx ligustri*, and *Pieris brassicæ*.

Schierbeek conceives of the primitive chrysalis as being provided with considerable power of movement and with a setal pattern. The pupa represents an immobilized subimaginal stage. As the pupal pattern generally agrees with that of the first larval instar, but only with that of the full-grown larva in cases in which the latter has retained the primitive design, the conclusion is drawn that the pupal stages as well as the first larval instar bear a primitive character in distinction to the later larval instars, which represent secondarily introduced phases of development.

* Proc. Akad. Amsterdam, xix. (1917) Nos. 9–10, pp. 1141–56 (10 figs.).
† Journ. Exper. Zool., xxiii. (1917) pp. 507–18.
‡ Proc. Acad. Amsterdam, xix. (1917) Nos. 9–10, pp. 1156–61.

Atypical Spermatozoa in Moths.*—J. Bronté Gatenby has studied the degenerate (apyrene) sperm-formation in moths with reference to the various bodies composing the spermatozoon. He worked with *Smerinthus populi*, *Pieris brassicæ*, *Pygæra bucephala*, and *Porthesia similis*. Atypical spermatozoa have been called "apyrene" and "oligopyrene" according to supposed absence of nuclear matter or its presence in small quantity.

Degeneration of cell elements takes place at all stages of spermatogenesis. Degeneration of the chromosomes just after the second maturation division leads to what have been called apyrene spermatozoa. But "apyrene," "oligopyrene," and "eupyrene" spermatozoa are not separate kinds in Lepidoptera, since all intermediate stages are to be found. It is suggested, indeed, that in Lepidoptera these terms lack the significance which has been attached to them.

Degeneration may set in just when the cell elements are about to be properly orientated before spermiogenesis, and in such cases the nucleus and head centrosome fail to join. The former sinks down the lengthening sperm. The acroblasts almost always accompany the nucleus, and form a normal acrosome. In degenerate spermatids where the chromosomes fail to join up normally, the macromitosome (Nebenkern) may be normally formed. The macromitosome may become normally elongated in sperms in which the nuclei are degenerate. It is suggested that the abnormal sperms are unable to bring about fertilization.

Individual nuclei can be reconstituted from separate chromosomes. At least partial interdependence of some cell elements is indicated by degenerate stages. Two centres of force, lodged respectively in the nucleus and in the centrosome, seem to be present.

Life-history of Piezodorus lituratus.†—E. A. Butler has studied this Pentatomid, which is very common on furze bushes. The drum-shaped eggs are laid on the unopened flower-buds, in a double row along one of the two sepals. On hatching, a circular lid is pushed up at one side, and there is what Fabre regarded as a spring. The larvæ are at first orange, with red eyes and a red patch on the back of the abdomen; they become brown and then black in front. The details of coloration are described. There are in all five instars, and the changes chiefly concern the thoracic segments. At each ecdysis the cuticle splits longitudinally along the mid-dorsal line of the thorax, and also transversely between head and pronotum. The cephalic sclerite remains entire. Not only are the limbs and antennæ drawn out of their sheaths, but also the rostrum and its setæ, and the principal tracheæ. Sexual union occurs in spring, and the male dies soon afterwards. Batches of eggs are laid at intervals through the summer. There is a green variety of larva and adult. Inside the egg-shells there is often found a minute Hymenopterous Proctotrupid, which hatches three weeks after the Pentatomid and eats the lid of the egg-envelope.

* Quart. Journ. Micr. Sci., lxii. (1917) pp. 465–88 (1 pl.).
† Entomologist's Monthly Magazine, liii. (1917) pp. 34–9 (2 figs.).

Gynandromorphic Earwig.*—J. P. Hill records a gynandromorph of *Forficula auricularia*. The right limb of the forceps was 3·25 mm. long and of the male type; the left limb was 2·75 mm. long and of the female type, being slender and only slightly curved. On the right side there was a well-developed testis with fully formed sperms; the left gonad was not observed, and was probably either absent or very rudimentary.

Melanic Aberrations in Acræinæ.†—C. N. Barker describes these in species of *Acræa*, *A. violarum* and *A. petræa*, in the Millar collection of butterflies in the Durban Museum. "Whatever the causes may be that bring it about, seasonally dimorphic butterflies of our sub-region are invariably more heavily patterned with black spots, bands or margins (in those species where they occur) than is the case in their dry season congeners; and melanic aberrations are simply extreme examples of this predisposition. Consequently they almost invariably occur in seasons of excessive rainfall."

Injurious Insects in Ireland.‡—George H. Carpenter reports on injurious insects observed in Ireland during 1914 and 1915. He deals, for instance, with the diamond-back moth, the turnip moth, the oak aphis, the potato aphis, the rosy rustic moth, the brassy flea-beetle, shield bugs (*Tropicoris rufipes* and *Palomena prasina*) on apples, the apple leaf-miner (*Lyonetia clerckella*), the cattle-biting louse (*Trichodectes scalaris*), and the so-called bee-louse *Braula cæca*, a wingless Dipteron, seventy specimens of which may occur on one bee.

Bird-infesting Mallophaga of Japan.§—Seinosuke Uchida continues his study of these insects, and deals with the genus *Lipeurus*, of which nineteen species are recorded. Descriptions are given of *L. annuliventris* from a grey fork-tailed petrel, and *L. turturis* from a turtle-dove.

δ. Arachnida.

Species of Demodex.‖—Stanley Hirst deals with *Demodex folliculorum* Simon from man, *D. caninus* Tulk from dog, *D. ratti* Hahn from *Rattus norvegicus*, *D. musculi* Oudms from mice, and *D. equi* Raill. from the horse. He indicates the differences in size, in the proportions of parts, in the capitulum and the spines.

Whip-tail Scorpion's Reaction to Light.¶—Bradley M. Patten has studied a Thelyphonid, *Mastigoproctus giganteus*, with reference to its reactions to light. The threshold for the kinetic effect of light was at about 0·16 candle metres. The response was clearly negative to all directive illumination which induced locomotion. The light operates as

* Proc. Zool. Soc. London, 1917, p. 213.
† Ann. Durban Museum, i. (1917) pp. 451–7 (2 pls.).
‡ Economic Proc. R. Dublin Soc., ii. (1916) pp. 221–37 (4 pls.).
§ Annot. Zool. Japon., ix. (1917) pp. 201–15 (3 figs.).
‖ Ann. Mag. Nat. Hist., xx. (1917) pp. 232–5 (2 figs.).
¶ Journ. Exper. Zool., xxiii. (1917) pp. 251–75 (4 figs.).

a stimulus inducing kinetic and directive responses, both through changes of intensity and constant intensity. Unilateral elimination of any part of the photoreceptive mechanism caused an unbalancing of subsequent reactions.

Striped Muscle of Limulus.*—H. E. Jordan has made a further study of the skeletal muscle of *Limulus* (1) to test his previous conclusions drawn from studies on the intercalated disks of vertebrate cardiac muscle, that these disks are to be interpreted as "irreversible contraction bands"; and (2) to find additional evidence to refute the theory that striped muscle can be interpreted in terms of "muscle-cells" and intercellular myofibrillæ. Both the skeletal and the cardiac muscles of *Limulus* consist of trabeculæ of finely granular sarcoplasm, holding regularly aggregated collections of myofibrillæ, and confined by a cell-membrane or sarcolemma; throughout the trabeculæ are scattered irregularly the numerous nuclei. In cardiac muscle the main trabeculæ and their branches form a loose-meshed syncytium. Neither type of muscle contains mesophragmata. Very rarely an intercalated disk of the simple-comb type appears in the cardiac muscle. Both types are very similar in respect of the presence and arrangement, in the same phase of contraction, of the disks and the telophragmata. These last are continuous membranes closely attached centrally to the nuclear wall, which is frequently drawn out into projections at the points of attachment, and peripherally to the sarcolemma. The sarcolemma is a very delicate membrane closely associated with the endomysium, but reacting differently to specific connective-tissue stains.

The evidence is unequivocal against an interpretation of structure in terms of muscle-cells and intercellular myofibrillæ. The nuclei of the growing muscles multiply by amitotic division. The myofibrillæ may be resolved into still finer fibrils to the limits of visibility (Heidenhain's "protomere" theory). The structurally different constituents of the *Limulus* sarcostyle are the telophragmata ("ground" or "Z" membrane) and the two disks ("Q" and "J"). These last, which alternate, probably differ only in the presence of a greater number of darker-staining "anisotropic" granules in the "Q" disk. In essential structure the cardiac and skeletal muscles of *Limulus* are closely similar, indicating a close functional similarity. The structure is, moreover, a fine illustration of the "law of biogenesis," in that it is practically identical with a stage in the early histogenesis of striped muscle in teleosts.

ε. Crustacea.

Photophores of Sergestes prehensilis.†—Arato Terao has made a careful study of the light-producing organs of this Decapod. With the naked eye they are seen as minute reddish spots, 157 in number, widely and definitely distributed. They give out dim greenish-yellow light in an intermittent way, each time starting suddenly and vanishing with as

* Carnegie Inst. Washington, Publ. No. 251 (1917) pp. 273–90 (3 pls.).
† Annot. Zool. Japon. ix. (1917) pp. 299–316 (3 figs.).

much promptitude after a longer or shorter period of illumination. Frequently the lighting-up occurred in serial succession, beginning with those at the head end and proceeding towards the tail, with rarely more than one alight at a time. It took one to two seconds from start to finish of the series of illuminations. Simultaneous luminescence of all the photophores was never observed, but groups were sometimes seen active at one time. After a night in captivity the power of luminescence disappeared.

A photophore consists of eight parts:—Lens, lens epithelium, photogenous layer, basement membrane, reflector, pigment mantle, connective tissue theca, and nerves.

The lens is nothing more than a strongly-thickened area of the transparent three-layered cuticle. Below it is the delicate epidermis, not infrequently showing karyokinetic figures. Directly inside is the relatively thick photogenous layer, with hæmal spaces between the photogenous cells. Not a few of the elements showed disintegration in process. There is a thin but distinct basement membrane. The "reflector" is not always present; it is a plano-convex or somewhat hemispherical body, made up of branching and anastomosing cells with horizontally extended slit-like interspaces; the cup-like pigment mantle of a reddish colour, sending out proximally a number of long chromorhyzæ. The theca is simply a condensed layer of the general connective tissue. The exact mode of innervation of the photophores was not determined.

Durban Malacostraca.*—T. R. R. Stebbing reports on a collection from Durban Bay. He describes in particular *Penæus durbani* sp. n. and *Sphæroma walkeri* Stebbing. Attention is called to Borradaile's note on the resemblance of *Huenia proteus* de Haan to a "leaf" of *Halameda*; the specimen from Durban was of the normal triangular shape. The illustrations are very fine.

Euphausids collected by the "Liguria."†—G. Colosi reports on the species of *Euphausia*, *Pseudeuphausia*, *Thysanopoda*, *Nematoscelis*, and *Stylocheiron* collected by the Duke of the Abruzzi on his "Liguria" voyage round the world. The following new species are described:—*E. uncinata*, *E. patachonica*, and *S. armatum*.

Copepod Parasite of the Sprat.‡—Marcel Baudouin discusses the disease of the sprat (*Clupea spratta*) caused by a parasitic Copepod (*Lernæenicus sardinæ*). In 1888 Joubin showed that this parasite caused sub-cutaneous or intra-muscular abscesses in the sardine. Baudouin shows that it may cause a kind of gangrene in the sprat. What it does is not to be confused with the work of another parasite of the sprat, *Nerocila affinis*.

* Ann. Durban Museum, i. (1917) pp. 435-50 (2 pls.).
† Publicazioni R. Ist. Stud. Sup. Firenze, ii. (1917) fasc. vii. pp. 165–202 (3 pls.).
‡ Comptes Rendus, clxv. (1917) pp. 410–11.

Ostracods of Upper Cretaceous.*—Frederick Chapman reports on a collection of Ostracods from the Upper Cretaceous of Need's Camp, Buffalo River, Cape Province. He describes *Bairdia africana* sp. n. and *Cythere postcultrata* sp. n.

Annulata.

Pharyngeal Glands of Earthworms.†—J. Stephenson has investigated the so-called "pharyngeal gland cells" in five common species of Lahore earthworms belonging to the Megascolecid genus *Pheretima* and the Lumbricid genus *Helodrilus*. They form a cellular mass, with white projecting lobules on the dorsal and lateral aspects of the pharynx, and penetrate inwards between the muscles of the dorsal wall. In various earthworms they have often been referred to as glandular. But they are not gland-cells in the usual sense, and do not communicate with the pharynx. The term "chromophil cells" is proposed for them because of their intense coloration by hæmatoxylin and similar stains. The so-called "septal glands" of earthworms are aggregations of similar cells at a more posterior level.

In the chromophil cells the deeply-staining matter is not equally distributed through the cell-body; the peripheral regions of the cells in general stain more lightly, and appear to be disintegrating, or merge into an intercellular substance. While most of the cells form a more or less compact aggregate on the surface of the pharyngeal mass, a number penetrate inwards towards the pharyngeal epithelium, and become progressively metamorphosed into fibrillar connective tissue. A capsule of flattened cells covering the mass, though present in part, is incomplete. The smaller masses of cells in *Helodrilus parvus* are frequently continuous with the peritoneal membrane, of which they appear as modifications. In *Helodrilus parvus*, and especially in all young earthworms, the inwandering and the connective tissue change of the chromophil cells is less marked; in very young specimens neither has taken place. The capsule is also more and more incomplete the younger the specimen.

The cells are to be looked on as of peritoneal origin; that is to say, they are modifications of the original lining cells of the cœlomic cavity. Hence the absence of capsule in the early stages; and hence the original limitation of the cells to the superficial portion of the pharyngeal mass. The main function of the cells is probably metabolic; but it is at present impossible to particularize further.

Siboga Aphroditidæ.‡—R. Horst describes a rich collection of Aphroditidæ from the East Indies, including representatives of all the sub-families. Three new genera are established:—*Paralepidonotus*, *Parahalosydna*, and *Weberia*. Two large groups are recognized: (1) Lepidonotidæ, with the lateral frontal lobes of the prostomium prolonged to form the basal joint of the paired antennæ; and (2) Harmothoidæ, with the lateral frontal lobes of the prostomium produced

* Ann. S. African Museum, xii. (1917) pp. 107–18 (1 pl.).
† Quart. Journ. Micr. Sci., lxii. (1917) pp. 253–86 (1 pl.).
‡ "Siboga" Expeditie, Monograph xxiv 1*b*. (1917) pp. 45–143 (pls. xi–xxix).

into two acuminate or rounded peaks, beneath which the paired antennæ arise. The author also describes a new species of *Bhawania*, representing the family Chrysopetalidæ. The body is elongated, with numerous segments, with paleæ arranged in a transverse row, only denticulated along the median edge. There is abundant illustration of setæ, scales, and parapodia.

Remarkable Leech.* —Asajiro Oka describes *Ancyrobdella biwæ* g. et sp. n. from the Biwa Lake, the largest and probably deepest lake in Japan. It was captured at a depth of about 80 metres. It is remarkable in the possession of three hooks directed obliquely backwards, at the anterior end of the long proboscis. Its internal structure is like that of Glossiphonidæ, e.g. in the lacunar system, the absence of lateral sinuses, the simple gonads, the shape of the food-canal. A superficial resemblance to Ichthyobdellids is deceptive.

Nematohelminthes.

Oxyuridæ of North African Reptiles.†—L. G. Seurat points out that the Oxyurids from reptiles form a group of very primitive forms. They are marked by broad lateral areas, composed of a small number of very large cells, with obvious nucleus, in a simple row. The very obvious excretory pore is in connexion with a refractive vesicle, into which four canals open in a letter X fashion. The male often shows lateral alæ (cuticular elevations) along the lateral areas, and sometimes broad caudal alæ. Seurat deals with *Pharyngodon* Diesing, *Thelandros* Wedl, *Tachygonetria* Wedl, *Strongyluris* A. Mueller.

New Nematode from Larval Fly.‡—D. Keilin points out that the larvæ of *Sciara pullula* Winn., which make galleries in dead wood, often show a large milk-white body filling the general cavity. This is the female of a Nematode (5 to 6 mm. in length) full of eggs. The larvæ also contain the much smaller males (1·9 mm. in length), transparent and delicate. Pairing occurs in the dipterous larva, and while the male degenerates the female enlarges. When mature it breaks from its host, lays eggs in the burrows, and dies. The adults of *Sciara* found infected were all females; these are expelled from the insect's body in a sort of hernia, and the insect behaves to them as if they were offspring. The larval Nematodes enter the larval insects, probably through the skin, for minute scars were seen. The name proposed for the new Nematode is *Aproctonema entomophagum*, the generic name referring to the absence of an anus.

Races of Trilobus gracilis.§—W. Stefanski discusses the reality of distinct races of this cosmopolitan Nematode, and upholds at least four. They are not modificational groups, for the same race may occur in very different surroundings.

* Annot. Zool. Japon, ix. (1917) pp. 186–93 (1 fig.).
† Arch. Zool. Expér., lvi. (1917) pp. 401–44 (14 figs.).
‡ Comptes Rendus, clxv. (1917) pp. 399–401 (6 figs.).
§ Rev. Suisse Zool., xxv. (1917) pp. 163–8.

Genus Hoplolaimus.*—R. Menzel discusses this genus of free-living Nematodes. It seems to be synonymous with *Jota* Cobb, *Ogma* Southern, and *Criconema* Hofmänner and Menzel. Nine species are recognized as well defined, and a useful comparative table is given showing how these differ.

Nematodes from Russian Birds.†—K. I. Skrjabin describes *Habronema seurati* sp. n. from *Falco cenchris*, and species of *Acuaria*, *Ascaridia*, *Filaria*, *Aprocta*, and *Cortortospiculum*. For the last genus and for *Diplotriæna* (represented in the collection by *D. bargusinica* sp. n. from a species of *Turdus*), the new sub-family of Diplotriæninæ is established. The members are Filariidæ with chitinous structures beside the mouth and in the œsophagus, tending to a tripartite arrangement, with two large unequal spicules.

Platyhelminthes.

Cestodes from Japanese Selachians.‡—Sadao Yoshida describes ten species of Cestodes, including *Orygmatobothrium velamentum* sp. n. from *Cynias manazo*, *Acanthobothrium ijimai* sp. n. from *Dasyatis akaei*, *Calliobothrium convolutum* sp. n. from *Cynias manazo*, *C. nodosum* sp. n. from the same, and *Rhynchobothrium laciniatum* sp. n. from the same, all from the spiral valve. These forms have numerous interesting features, e.g. the six triangular flaps projecting from the posterior border of the proglottid, which are well illustrated.

Life-History of Proteocephalus.§—A. R. Cooper has made a study of *Proteocephalus ambloplitis* Leidy, a cestode parasite of the Black Bass. The plerocercoid larva occurs in various organs. Different stages are described, and an account is given of the minute structure. The evidence points to *P. ambloplitis* having at least two intermediate hosts: the first, some unknown species of aquatic Arthropod ; and the second, either different species of minnows and small perch or the final host itself. Barbieri has collected evidence which goes to show (not quite conclusively) that the oncosphere of *P. agonis* develops into a young plerocercoid in *Bythotrephes* and *Leptodora*. Cooper describes the mature oncosphere of *P. ambloplitis*, which shows six hooks and three membranes.

Japanese Triclads.‖—Tokio Kaburaki describes *Ectoplana* g. n. from *Limulus longispina*. The body is narrowed at each end but blunt, usually milky white, without tentacles, with two eyes somewhat distant from the head-end, with the posterior branches of the gut united, with reproductive organs approaching those of *Procerodes*. Other Triclads from the King-Crab have belonged to the family Bdellouridæ ; this new form belongs to the Procerodidæ. The author also describes *Polycelis ijimai* sp. n. from a stream at Hokkaido, and gives a diagnostic key for Japanese Triclads.

* Rev. Suisse Zool., xxv. (1917) pp. 153–62.
† Parasitology, ix. (1917) pp. 460–81 (2 pls.).
‡ Parasitology, ix. (1917) pp. 560–92 (1 pl. and 4 figs.).
§ Contributions to Canadian Biology, ii. (1915) pp. 177–94 (3 pls.).
‖ Annot. Zool. Japon, ix. (1917) pp. 324–33 (2 figs.).

Effects of Light on Eye of Prorhyncus.*—W. A. Kepner and A. M. Foshee have investigated the effects of light and darkness on the eye of *Prorhyncus applaatus* Kennel. They find that stimulation by light results in a contraction of the accessory or pigment cell. In sustained darkness the cytoplasmic lamellæ of the pigment cell open up or move apart, and this results in the expansion of the cell. The three cytoplasmic regions of the retinula or visual cell show more or less marked changes in response to light and darkness. The nucleus-bearing part of the visual cells widened somewhat in the dark. The refractive middle segment (analogous to an ellipsoid of a vertebrate retinula) disappears in continuous illumination, and is most conspicuous in eyes that have been subjected to optimum illumination. The rhabdome in light-adapted eyes is a rounded cone-shaped body, while in those adapted to darkness it is an elongated trough-shaped structure with its long dimension directed parallel to the axis of the animal. Notwithstanding the analogy apparent between the structure of the retinula of a vertebrate and that of *Prorhyncus*, there is no analogy in functional changes. In the former it is the myoid that most markedly changes form ; in the latter it is the rhabdome that is most conspicuously modified in response to light and darkness.

Erratum.—In the October number of the Journal, p. 469, it was stated that *Tylocephalum marsupium* sp. n. had been obtained by Dr. Edwin Linton from *Rhinoptera bonasus*; it should have read "from *Aetobatis narinari*." From *Rhinoptera bonasus* Linton obtained in 1887 *Tylocephalum pingue*, the type of the genus.

Incertæ Sedis.

Study of Phoronidea.†—Alexander Meek discusses the distribution of *Phoronis ovalis* on the east coast of Britain, where it is the only species known, and the strong probability that its larva is *Actinotrocha branchiata*—the only larval form known from that area. He calls attention to the variability of the characters both larval and adult. A survey is made of the species *Phoronis ovalis* Strethill Wright, *P. euxinicola* de Selys Longchamps, *P. architecta* Andrews, *P. buskii* M'Intosh, and so on, and of the species of Actinotrocha. A brief account is given of the development and metamorphosis. The affinities are also discussed. According to the author *Phoronis* must be placed amongst the groups of Invertebrates which present a stomodeal blastopore; its metasome is directly homologous with the foot of Molluscs and with the part of the body of Gephyrea which intervenes between the mouth and the anus, the outgrowth which gives rise to the greater part of the body of the adult.

Bryozoa.

Cyclostomatous Bryozoa of Japan.‡—Yaichiro Okada deals with seven genera and thirty-two species, including the following new forms :—*Crisia simplex*, *Crisulipora ijimai*, *Tubulipora misakiensis*, *T. radiata*, *Berenicea ampulliformis*, *B. rotunda* and *Lichenopora sagamiensis*.

* Journ. Exper. Zool., xxiii. (1917) pp. 519–32 (1 pl. and 3 figs.).
† Report Dove Marine Laboratory, vi. (1917) pp. 33–48 (3 figs.).
‡ Annot. Zool. Japon, ix. (1917) pp. 335–60.

Echinoderma.

Genus Astropecten.*—L. Döderlein gives a detailed account of this genus, with great wealth of illustration of the spines and plates. He deals with eighty-five species, thirteen sub-species, and six varieties; of these forms he has himself investigated seventy-seven; there are twenty-three new species and sub-species. A "seriventral" group, with numerous ventro-lateral plates in several well-developed lateral rows, is represented by *A. schayeri* sp. n. A "pluriventral" group, with three to thirteen ventrolateral plates in one longitudinal row, is represented by such forms as *A. aranciacus* and *A. irregularis*. A "biventral" group, with only two ventral plates, is represented by such forms as *A. polyacanthus* and *A. vappa*. A full discussion is given of the various kinds of plates, spines, and paxillæ, and of the tufted pedicellariæ. The most primitive forms belong to the *schayeri* group, e.g. *A. schayeri*, *A. mesactus*, and *A. sphenoplax*, and from these the lines of evolution within the genus are traced.

Cœlentera.

Genus Antenella.†—M. Bedot discusses this genus of Hydroids, recognizing two groups of species. In group A there are two pairs of pleurohydrothecal nematothecæ; on each side the nematotheca of the first pair is fixed on the summit of a peduncle which carries near its base the nematotheca of the second pair. In group B there is a single pair of pleurohydrothecal nematothecæ. But this grouping is not intended as more than provisional, to facilitate the comparison of species.

South African Gorgonacea.‡—J. Stuart Thomson completes his account of these Alcyonarians, and records twelve new species:—*Anthothela parviflora*, *Melitodes faurii*, *M. grandis*, *Mopsella singularis*, *Wrightella trilineata*, *W. fragilis*, *W. furcata*, *Stachyodes capensis*, *Leptogorgia africana*, *L. aurata*, *Eugorgia lineata*, and *Stenogorgia capensis*. There are some excellent coloured figures and numerous drawings of spicules.

Porifera.

Reproduction and Development in Grantia compressa.§—Olga M. Jorgensen finds that the breeding season of this Purse Sponge is on the Northumberland coast from June to the beginning of September. At Plymouth, according to Orton, breeding begins in April; embryos are freed in June; there is a later reproduction from the year's larvæ in August; and disintegration occurs in autumn.

The ova are unusually large; there are two maturation divisions as usual; segmentation is total and equal as far as the seventh or eighth division, after which a small number of cells at one pole increase in size, become more granular, and divide much less quickly than the

* "Siboga" Expeditie, Monogrophie xlvi *a* (1917) 191 pp. (17 pls. and 21 figs.).
† Rev. Suisse Zool., xxv. (1917) pp. 111–29.
‡ Mem. Proc. Manchester Lit. Phil. Soc., lxi. (1916, published 1917) pp. 1–56 (5 pls. and 5 figs.).
§ Report Dove Marine Laboratory, vi. (1917) pp. 26–31 (1 pl.).

smaller cells. A pseudogastrula is formed. There seems to be "a period of very rapid growth from the beginning of segmentation up to the formation of the pseudogastrula—indeed so rapid that the expansion of the segmentation cavity proceeds more quickly than the rate of absorption of fluid from outside, hence a drawing-in of the less convex pole, i.e. the granular cells, and the production of the pseudogastrula." The invaginated cells become differentiated into two types—a single outer layer of lightly staining cells with definite nuclei and distinct outline, and an inner mass of closely packed elements filled with granular matter and of ill-defined outline. These cells are evidently concerned with the storing up of food reserves for the free-swimming period, and as this continues the segmentation cavity becomes so much decreased that the further growth must take place outwards, causing the subsequent evagination which leads to the stretching and rupture of the gastral epithelium.

It is held that the columnar ciliated cells are developed at the animal pole, which is the anterior end of the free-swimming larva, and the pole at which fixation occurs. The origin of the ova, according to the author, is from the choanocytes. This corroborates the view that Porifera are not far removed from colonial Choanoflagellata.

Influence of Vibrations on Form of Certain Sponge-spicules.*— Arthur Dendy and J. W. Nicholson have studied the discorhabds of *Latrunculia*, and more especially the oxydiscorhabd of a related new genus, with a view of determining whether the whorls correspond in position to the nodes of a vibrating rod. There is in the oxydiscorhabd a close agreement between the observed and the calculated positions of the whorls. The strength of the currents in the sponge must tend to set up vibrations in elastic bodies of suitable shape embedded in the almost liquid mesoglœa. The special accumulation of silica on the nodes would be due not directly to the vibrations of the spicule, but to the effect of the vibrations on the formative cells, which may seek out the least disturbed positions.

Protozoa.

Effect of Media of Different Densities on the Shape of Amœbæ.† Mary J. Hogue grew an *Amœba limax* on agar media of different densities, made up with Witte's pepton. On 2·5 p.c. agar the amœbæ are rather circular, with few pseudopodia. Compared with those grown on the thin medium, they are more numerous and often massed together. On 0·5 p.c. agar the amœbæ are elongated, with irregular pseudopodia. They move freely on this medium and are evenly distributed over it. On 1, 1·5, and 2 p.c. agar the amœbæ show the forms intermediate between the amœbæ grown on 0·5 and on 2·5 p.c. agar respectively. The media best adapted to the growth and multiplication of the amœbæ are 1·5 and 2 p.c. agar plus 0·4 p.c. Witte's pepton.

* Proc. Roy. Soc., Series B, lxxxix. (1917) pp. 573–87 (15 figs.).
† Journ. Exper. Zool., xxii. (1917) pp. 565–72 (9 figs.).

Foraminifera from South African Upper Cretaceous.*—Frederick Chapman reports on a collection of Foraminifera from the Upper Cretaceous of Need's Camp, Buffalo River, Cape Province. He defines *Spiroplecta deflata* sp. n., and notes the generally Cretaceous aspect of forms like *Haplophragmium neocomianum* and *Spiroplecta anceps*. Forms like *Nodosaria zippei*, *N. sulcata*, *Cristellaria parallela*, *C. intermedia*, and *C. secans* mark the Upper Cretaceous character of the beds.

North Pacific Foraminifera.†—J. A. Cushman completes his monograph of the Foraminifera of the North Pacific Ocean, dealing in this sixth instalment with the Miliolidæ. Many authorities have ranked this family as primitive because it has apparently no pores in the tests, but the discovery by several workers that the earlier chambers of some of the highest genera in the family have a perforate test shows that the ancestry must have been perforate. The greatest development as regards number of species and complexity of structure seems to have been in the late Cretaceous and early Tertiary. The author discusses the proloculum or initial chamber, the "embryonic" stages, and the development of the shell in *Cornuspira*, *Opthalmidium*, *Planispirina*, *Spiroloculina*, *Quinqueloculina*, *Triloculina*, *Biloculina*, *Idalina*, and *Peneroplis*.

Entamœba gingivalis from Human Mouth.‡—T. Goodey and A. W. Wellings have brought together evidence from two sources: viz. (1) the cytological investigation of the ingesta of the amœba (*E. gingivalis*), and (2) the examination of a variety of oral conditions, as to the relation of the amœba to *Pyorrhœa Alveolaris*. The first evidence leads them to the conclusion that the amœba so far from being a destroyer of healthy tissues in the mouth is in reality a devourer of waste nuclear material derived from disintegrated salivary corpuscles together with bacteria, and is therefore most probably a useful scavenger. The second evidence leads them to the conclusion that the amœba may be found in healthy and unhealthy mouths, and is especially likely to be found in situations where there is possibility for the accumulation of food debris. The general conclusion of the authors is that there is no evidence to show that *E. gingivalis* is the cause of disease.

New Trichomonad from the Human Mouth.§—T. Goodey describes *Tetratrichomonas buccalis* sp. n. from the human mouth. It occurred in food debris and showed great amœboid activity, sending out pseudopodial extensions both anteriorly and posteriorly. It appears to ingest bacteria. There are four flagella arising from a blepharoplast; there is an undulating membrane along most of one side, and with it there seems to be associated a chromatinic basal rod or parabasal body. An axostyle extends from the nucleus to the posterior end, where it sometimes projects in a spike. The species seems different from that found in the intestine.

* Ann. S. African Museum, xii. (1917) pp. 107–18 (2 pls.).
† U.S. Nat. Museum, Bull. No. 71 (1917) pp. 1–103 (39 pls.).
‡ Parasitology, ix. (1917) pp. 537–59 (3 pls.).
§ Parasitology, ix. (1917) pp. 554–9 (1 pl.).

Blastocystis hominis.*—N. H. Swellengrebel has found two cases of the occurrence of "*Blastocystis*" where the presence of *Trichomonas* or *Chilomastix* could be excluded with absolute certainty. Therefore "*Blastocystis*" cannot be a normal developmental form of either. The size of blastocysts varies greatly; the larger they grow the smaller becomes the peripheral fringe of cytoplasm. They were never found except when some other parasite was present. It is probable that "*Blastocystis*" is not the name of a genus, but of a peculiar form of degeneration to which representatives of different genera of intestinal Protozoa are liable. It is probable that Alexeiff's *B. enterocola* is different from forms described in man under the same name.

Race of Paramecium with Extra Contractile Vacuoles.†—Robert T. Hance has studied a race of *Paramecium caudatum* with two to seven contractile vacuoles. It may possibly have arisen under the influence of high temperatures. The individuals range from 167 μ to 307 μ, and are unusually strong and resistant. A slightly denser portion extends in some individuals as a band across the middle. The extra vacuoles are generally at the posterior end. The number may increase during the individual lifetime. Various conditions affect the number of vacuoles present in the individual, such as the rate of division and the age of the culture medium. Though extra vacuoles may not appear for several generations for the above reasons, the potentiality is not lost. The division rate ranges between one and five times in twenty-four hours. Besides being influenced by the rate of division the vacuole number may apparently be increased in the individual by the presence of katabolic products in the environment. To heat, cold, distilled water, etc., the resistance of the race is very high. The rate of pulsation of the vacuoles is slightly slower than in the common race, but the power of excretion is greater.

There is some evidence that conjugation is induced by the concentration of katabolic products in the environment. Conjugation has no effect on the new character.

It may be that a potentiality for *extra* vacuoles rather than for a definite number is passed on from generation to generation, and that this potentiality is affected by various conditions during the lifetime of the individual. Selection has no effect in raising or lowering the vacuole number. The location of the vacuoles in the parent has an immediate but temporary effect on the number possessed by the offspring.

Effect of Thyroid Diet on Paramecium.‡—Waldo Shumway finds that a diet of thyroid substance, either as emulsion of raw thyroids or as a suspension of the commercial powder, produces on *Paramecium aurelia* or *P. caudatum* a constant and significant increase of 65 p.c. in the rate of division over that observed in a hay infusion. The thyroid

* Parasitology, ix. (1917) pp. 451–9 (2 pls.).
† Journ. Exper. Zool., xxiii. (1917) pp. 287-333 (3 pls. and 12 charts).
‡ Journ. Exper. Zool., xxii. (1917) pp. 529-63 (12 figs.).

is the only gland of internal secretion that has this effect. Boiling the thyroid produces no change in the reaction. Iodothyrin and iodine fail to produce the thyroid effect. After prolonged thyroid treatment individuals revert to the normal division-rate when returned to the control medium.

The life-history curves of the treated lines show the same depression periods at the same time intervals as the control lines, and the thyroid produces the greatest acceleration of the division-rate when the control line is dividing most rapidly.

The animals ingest and digest particles of the thyroid. There is no significant difference between the number of gastric vacuoles formed in a given time between the thyroid-fed and the control individuals. But the thyroid-fed forms show profound disturbances of the excretory system, and the contractile vacuoles may increase from two to three. The thyroid-fed forms show at all times a highly vacuolated protoplasm, such as has been described for starved individuals. This is true even during the periods of most rapid division. It has been shown that these large vacuoles are to be considered non-contractile excretory vacuoles. It is suggested that the results of thyroid-feeding in *Paramecium* are due to the presence of a remarkably stable hormone in the thyroid, which may be classified among "dissimilatory" hormones.

Reactions to Colours.*—S. O. Mast has studied the relations between spectral colour and stimulation in the lower organisms, e.g. *Euglena*, various Monads, *Eudorina*, larva of *Arenicola cristata*, earthworms, larvæ of blowfly. In the fifteen species studied stimulation by light was found to depend upon the wave-length, i.e. certain spectral colours are much more efficient as stimulating agents than others. If the light in the spectrum on either side of the maximum be made sufficiently *intense* it becomes more effective than that at the maximum. There is no evidence indicating the presence of colour-vision in any of the forms studied. Bees are the lowest forms in which colour-vision has been clearly established.

The distribution in the spectrum of stimulating efficiency differs in some species that are closely related (*Gonium* and *Pandorina*) and is essentially the same in some that are not closely related (*Euglena* and *Lumbricus*). The shorter wave-lengths are relatively more efficient for green plants than they are for any animals, and there is nothing in the nature of colour-vision in any of the plants. The contention therefore that the reactions to colours in plants and animals is the same is not well founded, although some of the chromatic reactions in animals may be essentially the same as those in plants.

The distribution in the spectrum of stimulating efficiency in any given species is continuously the same, regardless of changes in physiological states, environment, and character of response, e.g. it is the same in individuals when they are negative as it is when they are positive. As to the nature of the chemical processes associated with the responses no definite conclusions can be drawn.

* Journ. Exper. Zool., xxii. (1917) pp. 471–528 (4 figs.).

Reproduction of Dinenympha gracilis Leidy.*—Antonio de Zulueta describes the division of this Flagellate commensal from the intestine of *Termes lucifugus*. There is distinct mitosis, in which the centre of division is the basal body of the undulatory membrane. The nuclear membrane persists through all the phases. There is an intranuclear achromatic spindle and an equatorial plate formed by differentiated chromosomes. The author compares this type of division with that occurring in other Protozoa.

New Astomatous Ciliate.†—Iwaji Ikeda describes *Metaphrya sagittæ* g. et sp. n. from the cœlom of Sagitta. It is a radially symmetrical organism, except that the anterior end is somewhat deflected towards one side. Fine but long cilia occur in twelve longitudinal shallow grooves. Below an investment of finely granular cytoplasm, indistinctly differentiated into ectoplasm and endoplasm, there is a curious strongly refractive wavy layer, and within that a clear, fluid-like, non-plasmic substance. Sections show that the refractive layer is a basketwork-like macronucleus, made up of threads of chromatin. The micronucleus lies in the transverse plane passing through the middle of the body. It is spindle-like, 5 μ in its major diameter. The central substance may be reserve material, perhaps a colloid of a protein nature.

Small individuals showed some important peculiarities. The youngest was 20 μ by 10 μ in contrast to the largest 0·25 mm. by 0·13 mm. The body was covered uniformly with short cilia. The macronucleus was of much simpler configuration—a relatively thick and sinuously winding thread, which may bear some short branches ending freely. The micronucleus was much as in the adult, but the central non-plasmic substance was entirely absent. Excretory vacuoles are present, and non-plasmic spherules. It is probable that this interesting form should be referred to Anoplophryiidæ, and regarded as a highly-advanced representative.

Sporozoa from Fishes.‡—J. W. Mavor describes from the St. Andrews region, Canada, some interesting Sporozoa from fishes, especially from the gall-bladder, *Ceratomyxa acadiensis* sp. n., *Myxidium bergense* Auerbach, *Goussia gadi* Fiebiger, etc. In the gall-bladder of the hake (*Urophycis chuss*), the new species of *Ceratomyxa* was usually found attached to an undetermined parasite (probably a species of *Myxidium* or *Chloromyxum*), which is itself attached to the gall-bladder.

* Trabajos Mus. Nacional Ciencias Naturales, Serie Zool., No. 23 (1915, received 1917) pp. 1–26 (1 pl.).
† Annot. Zool. Japon, ix. (1917) pp. 317–24 (6 figs.).
‡ Contributions to Canadian Biology, i. (1915) pp. 25–38 (1 pl. and 6 figs.).

BOTANY.

GENERAL,

Including the Anatomy and Physiology of Seed Plants.

Cytology,

Including Cell-Contents.

Reaction of Plant Protoplasm.*—A. R. Haas has studied the actual and the total acidity of the lemon, cranberry, grapefruit, apple, orange, rhubarb, etc. There appears to be no constant relation between the total acidity due to the presence of undissociated and dissociated acid and the actual acidity due to the latter, since "variations occur in different plants and in different parts of the same plant." The actual acidity in the lemon and the cranberry is surprisingly high, but the writer finds that in the former the acid is contained in special sacs, the protoplasm being far less acid; in the cranberry the acid appears to be contained in the living cells, but it is possible that it may be confined to special vacuoles.

Staining of Microscopic Organisms.†—J. B. Hill describes the staining of *Sphærella*, *Pandorina*, and *Volvox*, and other unicellular and colonial organisms. The method used is briefly as follows: After immersion in a suitable killing solution, the material should be filtered and left on the filter-paper in the funnel, where it must be washed with distilled water and treated with 0·1 p.c. iron-alum solution. Re-wash with distilled water and treat with 0·1 p.c. aqueous hæmatoxylin stain; again wash with distilled water, and then differentiate the stain with 0·1 p.c. iron-alum solution. Finally, give a thorough wash with distilled water. Dehydrate with glycerin, and use Venetian turpentine in mounting. When alcoholic stains are used dehydrate before staining. The two chief factors in obtaining successful mounts are: (1) the use of a funnel, filter-paper, and wash-bottle, as in quantitative chemistry; (2) "dehydration and the staining methods of the Venetian turpentine method of mounting."

Structure and Development.

Vegetative.

Morphology of Keteleeria.‡—A. H. Hutchinson has made a careful study of the morphology of *Keteleeria Fortunei* in order to throw light

* Bot. Gaz., lxiii. (1917) pp. 232–5.
† Bot. Gaz., lxiii. (1917) pp. 410–12.
‡ Bot. Gaz., lxiii. (1917) pp. 124–34 (2 pls. and 3 figs.).

upon its systematic position. The author considers that it should be regarded as a distinct genus belonging to the Abietinæ, and supports this view on the following characters: 1. The cones are erect, with persistent scales, the latter being separate from the bract nearly to the base; there is a single megaspore mother-cell. 2. The staminate cones are in clusters on fertile branches with two abaxial microsporangia on each sporophyll; the pollen is winged. 3. The pollen when shed consists of two polar cells, an antheridial cell and the tube-nucleus. 4. There are no resin-ducts in the secondary wood except as the result of wounds; ray-tracheids are never formed. 5. There is a large cotyledonary tube, a fact of significance in connexion with theories of polycotyledony. 6. The central axis is prolonged into the primary root. 7. The leaves are spirally arranged and have two vascular strands with two marginal resin-ducts. 8. The sieve-tubes occur in single, interrupted rows, with plates on the terminals; there is protoplasmic connexion through the small perforations of the plates.

Leaf Nectaries of Gossypium.*—E. L. Reed describes the glands found on the midrib, and sometimes on the other principal veins of the underside of the leaves of *Gossypium hirsutum*. These glands are "oval-shaped depressions, filled with closely-crowded multicellular papillæ and surrounded by a thick wall of epidermal cells." The papillæ arise from epidermal cells which cease to develop normally, but divide so as to form short pedestals; the numerous divisions which take place before the papillæ are fully formed are strongly reminiscent of the development of the antheridia in *Riccia*.

Wounding and Regeneration of Plants.†—L. Daniel publishes the results of further investigations as to the effects produced by wounding different parts of a plant. The first series of experiments was made upon the adult form of *Eucalyptus globosus*, and as a result of decapitation those portions of the tree which replaced the branches which had been removed resumed the juvenile form for several months. The author believes that this is the first instance of the kind to be recorded, but that such cases will prove to be by no means uncommon. The second series of experiments deals with the effects produced by cutting growing roots of the common carrot. In some cases portions of the tap-root were removed before tuberization had commenced; in others the wounds were made subsequent to tuberization, and at some distance from the neck. In the first case the cut root formed two branches which were more or less unequal in length, and with greater or less response to geotropism, according to the stage of development when the wounds were made. In the second case the main root ceased to grow and merely healed, but some of the lateral roots elongated and swelled in an irregular manner. The author is of the opinion that the malformed roots so frequently found by growers are mainly due to wounds made by slugs or other soil-pests during early stages of growth.

* Bot. Gaz., lxiii. (1917) pp. 229–31 (2 pls. and 1 fig.).
† Rev. Gén. Bot., xxix. (1917) pp. 65–72.

Summer and Winter Leaves.*—J. P. Stober has studied the respective peculiarities of summer and winter leaves in a large number of herbaceous plants. The author made transverse sections through the centre of leaves taken from different plants of the same species at different times and in different habitats. The differences were most clearly marked in plants from different habitats, and were observed in the epidermal hairs, walls and cells; also in the cuticle, stomata, blade, and collenchyma. In both summer and winter forms hairs are more abundant in the upper than in the lower leaves, but usually are more abundant in summer than in winter leaves. Stomata are more abundant, rounder, and more numerous in summer than in winter. The winter leaves have larger epidermal cells with sinuous lateral walls. The blade of winter leaves is usually thicker than that of summer leaves, unless the latter are of xerophytic type. Winter leaves have thicker epidermal walls and cuticle than summer ones except in xerophytes. The palisade parenchyma is better organized in summer leaves, but the thickness of the palisade cells is greater in winter leaves. There is a greater amount of collenchyma and more air-spaces in winter than in summer; sclerenchyma is equally developed in summer and winter, but conductive tissue better in winter. On the whole winter leaves are more mesophytic in structure than summer leaves.

Reproductive.

Gametophytes of Taxus canadensis.†—A. W. Dupler is investigating the morphology of this American representative of the Old World *Taxus baccata*. He finds that in general the gametophyte history agrees with that reported for *T. baccata*. Microspore formation takes place in the autumn; there are no indications of prothallial cells. The pollen-grain is uninucleate when shed. The pollen-tube penetrates the nucellus very rapidly and enlarges excessively about the female gametophyte. Three divisions take place in the development of the male gametophyte; the body-cell divides into two unequal male cells, the larger of which functions in fertilization. Several megaspore mother-cells are formed, of which only one usually functions, although two of them may form megaspores. The megaspore mother-cell is the usual winter condition, but megaspores may be formed, and the female gametophyte may consist of several free nuclei before winter. Following the free nuclear stage of the female gametophyte, radial walls come in, closing the cavity before the appearance of periclinal walls. The archegonia appear early in the endosperm; the central cell is the functional egg, no ventral canal cell or ventral nucleus being formed. More than one female gametophyte in an ovule is common; as many as five were observed. In fertilization the nuclear contents of the pollen-tube are discharged into the egg; a cytoplasmic sheath is formed about the two fusing nuclei. From pollination to fertilization may be as short as one month. Mature seeds have been collected six weeks later.

* Bot. Gaz., lxiii. (1917) pp. 89–109.
† Bot. Gaz., lxiv. (1917) pp. 115–36 (4 pls.).

Embryogeny in Euphorbia.*—W. Weniger has studied the development of the embryo-sac and embryo in *E. Preslii* and *E. splendens*. The author finds that in both species the cyathium-papilla arises between two bracts, and gives rise to staminate flowers, involucre, ovules, carpels, and finally to secondary staminate flowers. The megaspore mother-cell arises in the sub-epidermis; an axial row of four megaspores is formed, the lowest of which forms the embryo-sac, while three disintegrate. The inner integument develops first, but is soon outgrown by the outer. When mature, the long, narrow embryo-sac is deeply embedded in the nucellus. In *E. Preslii* the structure is that of a typical angiosperm but it seems probable from certain peculiarities that in *E. splendens* the four antipodal nuclei undergo a second division. The obturator arises from the placenta, filling the beak-like prolongation of the nucellus, and disintegrates as the embryo develops. At the first division of the egg of *E. Preslii*, endosperm-nuclei lie between it and the micropylar end of the embryo-sac. The embryo is a round mass of cells, which elongates to form two cotyledons and a root-cap. The ripe embryo is straight and embedded in endosperm, except at the tip of the root-cap. *E. splendens* has a short suspensor, but *E. Preslii* has none.

Physiology.

Nutrition and Growth.

Environment and Nectar Secretion.†—L. A. Kenoyer has studied the influence of environment on the secretion of nectar. After a brief historical summary of previous investigations, the author gives an account of his experiments conducted under various conditions of humidity, rainfall, temperature, atmospheric pressure, light, fertility of soil, flowering period, and age of flower. He finds that an increase in humidity causes increase in the water secreted by the nectaries; excess of water causes reduction of sugar-surplus; rain causes much loss of nectar-sugar. The rate of secretion of sugar and water increases with temperature up to a certain optimum, but the accumulation of sugar varies inversely as the temperature. Alternations of high and low temperatures cause the maximum secretion of sugar. Variation in pressure has no marked effect on secretion, but darkness diminishes sugar-secretion. The amount of sugar secreted varies directly with conditions of growth and vigour of the plant. Nectar is most abundant early in the flowering season, while accumulation and secretion of sugar are greatest near the time of the opening of the flower.

Irritability.

Mechanism of Movement in Drosera rotundifolia.‡—Henry D. Hooker has studied the movements of the leaf tentacles of *Drosera* which he describes as growth phenomena.

The osmotic concentration in cells of *D. rotundifolia* tentacles

* Bot. Gaz., lxiii. (1917) pp. 266–81 (3 pls.).
† Bot. Gaz., lxiii. (1917) pp. 249–65.
‡ Bull. Torrey Bot. Club, xliv. (1917) pp. 389–403.

was measured by plasmolysis in potassium nitrate and glucose solutions. Measurements were made on straight, bending, bent and unbending tentacles. The osmotic concentration in the cells on the abaxial side of the stalk, in the growing region, was found to diminish during bending; no change was observed on the adaxial side. The decrease in osmotic concentration is accounted for by the increase in volume of the cells, and is therefore considered an effect and not a cause of their elongation. There is no indication that changes in permeability occur. The elongation is produced by a decrease in the elasticity of the cell-walls, and is later fixed by growth. The movement of tentacles is therefore brought about by the same mechanism found in geotropically reacting organs, where a decrease has been observed in the osmotic concentration in the cells whose growth causes bending.

Similarities between hydrotropic reactions and autotropic unbending of tentacles and of geotropically bent roots indicate that the growth on the concave side which brings about the unbending is a response to changes resulting from the difference in osmotic concentration present during bending. As in hydrotropic reactions, growth takes place on the side with the higher osmotic concentration.

CRYPTOGAMS.

Pteridophyta.

(By A. Gepp, M.A., F.L.S.)

New Investigations of Athyrium and Botrychium.*—F. K. Butters begins a series of critical studies of some of the North American ferns which have a very wide and somewhat anomalous distribution. Being of opinion that too much reliance has been placed on such superficial characters as details in the form and cutting of the fronds, he has deemed it wise to study such technical characters as the size, form and sculpture of the spores, and details of the structure of the sporangia, sori, indusia and scales, in the hope of finding characters of a more stable nature. This investigation has led to the separation of species and varieties in the case of several common groups of ferns, and in other cases to the recombination of forms supposed to be distinct. And the result is to make the ferns agree more with the laws of distribution applicable to the phanerogams.

I. The first study treats of the genus *Athyrium*. Among the conclusions reached are the following: (1) In the Eastern United States and Canada there are two distinct species of Lady Ferns, neither of which is conspecific with *A. Filix-femina* of Europe; one, *A. asplenioides*, is prevailingly southern in its distribution; the other, *A. angustum*, is prevailingly northern. (2) The plants of the north-west are conspecific with the European plant, some forms differing in minor points. (3) The Californian plants and those of the Southern Rocky Mountains differ

* Rhodora, xix. (1917) pp. 169–216 (1 pl.).

more markedly from the European, but are not clearly distinct from the more northern form, and therefore are best considered as an aberrant geographical variety. (4) A boreal and high Alpine fern found in Eastern Quebec and in the Alpine areas of Western North America is a clearly distinct geographical variety of the Old World *A. alpestre*.

II. The second study is concerned with *Botrychium virginianum* and its American varieties. As a result of his investigation the author has drawn up a key comprising the type, five varieties, and *B. cicutarium*.

Systematic Significance of the Fern-spore.* — J. B. Kümmerle maintains that the fern-spore, whether radial or bilateral, has a systematic significance. The bilateral spore-form is characteristic of *Lonchitis*; the species of *Lonchitis* which possess tetrahedral spores are transferred by the author to the genus *Antiosorus* Roem. Whether the spore-form serves as a generic character in other genera of Polypodiaceæ, Schizæaceæ and Gleicheniaceæ, is determined by vegetative characters, with which there exists an unmistakable internal and external morphological agreement. Even if the spore-form is not characteristic for the genus, it still should be mentioned, since the two spore-forms may be useful guides for subgenera, sections, etc., as, for instance, in *Antrophyum* according to Benedict. In any case a study of the spore-form is important. There are also cases where in a certain species one of the spore-forms is prevalent.

Lonchitis.† — J. B. Kümmerle publishes a monograph of the genus *Lonchitis*, in which he recognizes ten species and three forms, while several species hitherto placed in this genus are transferred to *Antiosorus* and elsewhere. An emended generic diagnosis is given, which represents Christensen's subgenus *Eulonchitis*. The species are distributed in four sections—Curroriæ, Pubescentes, Glabræ, Histeropteridæ — which are distinguished by the colour of the frond, the kind of pubescence, and the presence or absence of paraphyses. The species are chiefly African; and a key for their easier determination is provided.

Coniogramme.‡ — G. Hieronymus publishes a monograph of the genus *Coniogramme*. As characteristics of the genus, and for the discrimination of the species and varieties, the author takes into account the rhizome, the scales on the rhizome and stipes, the stipes and rhachis, the fronds and the sori. Points of difference occur in the thickness, length, form and division of the vascular bundles in the rhizome; and in the relative sizes of the scales and in the development of the apex. The stipes and rhachis show only slight differences, concerned with possible furrows or channels, colour, length and thickness. The development of the frond is of importance. When young it is probably

* Bot. Közlem., xiv. (1915) pp. 159–66. See also Bot. Centralbl., cxxxii. (1916) p. 524.

† Bot. Közlem., xiv. (1915) pp. 166–88. See also Bot. Centralbl., cxxxii. (1916) pp. 524–5.

‡ Hedwigia, lvii. (1916) pp. 266–328. See also Bot. Centralbl., cxxxii. (1916) pp. 458–9.

simple in all species, later fronds are always pinnate. The number of the pinnæ could not be established on the herbarium material at the author's disposal. Differences in the shape of the pinnæ are concerned with the length and breadth, and with the form of the drip-points. Very definite characters for the determination of the separate species and varieties are provided by the development of the margin of the pinnæ. Another important character is the position of the ends of the lateral nerves and their branches which are thickened into hydathodes. In certain species the hairs occurring on the lower surface of the pinnæ are taken into account. The sporangia show differences in size; and the annulus differs in regard to the number of cells of which it is composed. Similar differences occur in the paraphyses. The size of the three-lobed tetrahedral spores is characteristic of many species. The author deals at length with the geographical distribution of the different species, and describes a certain number of new ones. A key for the determination of the species and varieties is given, as well as careful and detailed diagnoses of each.

Botrychium Lunaria. * — Z. Zsák writes on the occurrence of *Botrychium Lunaria* in the Pesth Comitate. On the farther side of the Danube it is found in three mountain groups: in the west on the Köszeg Mountains; eastward from there on the south-westerly outlying portion of the Vértes Mountain; and north-easterly on the Ofner Mountains, where it occurs at a height of about 370 m., near Pilis-Szentivén, associated with some seven rare flowering plants.

British Ferns.†—S. L. Bastin publishes a little volume on our native ferns and fern-allies. It is of a popular nature, and treats of classification, life-histories, extinct ferns, and then discusses each of our British species in turn, giving a photograph of each.

New Ferns from Borneo.‡—E. B. Copeland publishes descriptions of forty-four new species of ferns from Borneo, chiefly from collections made on Mount Kinabulu by Clemens and Topping, and partly in Sarawak by F. J. Brooks and others. These specimens referred to fourteen genera, one of which, *Oreogrammitis*, is new to science, and stands between *Scleroglossum* and *Polypodium*.

Bryophyta.

(By A. Gepp.)

Structural Adaptations in Hepaticæ.§—K. Müller writes on the adaptation of liverworts to conditions of extreme light. He first deals, however, with adaptations exhibited by species to make the most of insufficient illumination, a condition which is less common. Among the

* Magyar Bot. Lapok., xv. (1916) pp. 82–5. See also Bot. Centralbl., cxxxii. (1916) pp. 525–6.

† British Ferns, and how to Know Them. London: (1917) 136 pp. (36 figs.).

‡ Philippine Journ. Sci., Bot., xii. (1917) pp. 45–65.

§ Ber. Deutsch. Bot. Gesell., xxxiv. (1916) pp. 142–53 (figs.). See also Bot. Centralbl., cxxxii. (1916) pp. 475–6.

Marchantiaceæ, *Cyathodium* has globular cells on the upper surface, which allow of a concentration of light on the chlorophyll-grains lying below. This causes also a partial reflection of light, and thus, like *Schistostega*, it glows with an emerald-green light. In Jungermanniaceæ the plants react to a weak illumination by enlargement of the leaf-surface, convexity of the cells, and heliotropic curvature. Adaptations to protection from light are much more frequent, and have been indicated as xerophytic adaptations, which are also to be found. Absorption of red and yellow light-rays takes place in red-brown, violet, and sometimes almost black liverworts, in which the coloration is limited to the cell-wall (regarded by Stahl as an arrangement for storing up warmth). Marchantiaceæ of the Mediterranean region, which have violet scales on the lower surface of the thallus (*Targionia*, *Grimaldia dichotoma*), protect themselves from superfluous light by an incurving of the thallus. A yellowish colouring of the walls of the epidermis cells should hinder the passing of blue and violet rays. Reflection of the light by dead, air-conducting cells, which give the plant a silver-grey appearance, occurs in many liverworts of the high mountains, as, for instance, *Gymnotrichium*, *Anthelia*, and others. In these the upper free-standing portion of the imbricating leaves is dead. A glittering wax-like surface occurs in species of *Plagiochasma* and *Marchantia*. In species of *Riccia* a cell void of chlorophyll is found at the apex of each of those columns in which the assimilation-cells are arranged. In *R. melitensis* there are as many as four to five. The reflection of the light-rays, entering by this means, causes the surface of the thallus to appear whitish-green. The formation of cilia and bristles serves also to diminish the light. An interesting analogy is seen between the fenestrate leaves of *Mesembryanthemum* and the fenestrate thallus of Ricciaceæ, in which the above-mentioned epidermis cells, devoid of chlorophyll, are more or less closely adpressed, while the columns of chlorophyll cells have wide intercellular spaces. Light cannot easily penetrate through the openings between the epidermis cells. In *Riccia Sommieri* the light- and air-channels are still further limited by a layer of cells with thickened walls below the epidermis. *Exormotheca Welwitschii* from Algiers shows the most interesting structure. The basal tissue, filled with oil as reserve material, is entirely buried in the ground. Then comes the lower assimilative tissue, and, upon that, high air-chambers which are surrounded by cells with pale yellowish walls and clear contents and stomata above, which act also as windows for light. The light can also reach the assimilative tissue reflected, filtrated, and broken. The principal function of these air-chambers, apart from transpiration, would seem to be to give protection from intensive light.

Duration of Sporogonial Development in Mosses.*—W. Krieger publishes the results of his investigations on the time of development of sporogonia in :—1. The same moss, in a similar habitat, in one year. 2. The same moss, in a similar habitat, in the course of several years.

* Inaug. Dissert. Univ. Münster (Dresden, 1915) pp. 1–51. See also Bot. Centralbl., cxxxiv. (1917) pp. 55–6.

3. The same moss, in different habitats, in the same year. 4. Different mosses under similar conditions—that is, in the same habitat and the same temperature, with similar water supply, and during the same period. 5. Different mosses in different habitats. The investigations were conducted principally with common, easily observed mosses; and the results are stated fully and accompanied by illustrations. The principal points are as follows:—1. Mosses of the same species, in a similar habitat, and in the same year, take about the same time for the development of the sporogonium. Variations are due to differences in the time of fertilization. 2. Most mosses take a longer time for sporogonial development in Germany than in Scandinavia. 3. The length of time does not alter considerably in the course of several years. 4. The kind of habitat does not materially influence the time of development, though damp places may shorten it somewhat. 5. The growth in thickness of the apex of the sporophyte, which precedes the formation of the capsule, does not begin until the sporophyte has attained its definite length. 6. In mosses with little or no capsule-assimilation the development-time of the sporogonium depends entirely, or almost entirely, on the structure of the stem; in mosses with great assimilation in the capsule it is dependent as a rule only until the seta attains its full length. Usually the time of development is shorter the better the capsule assimilates, or, when there is no capsule-assimilation, the more sturdy the gametophyte is. 7. The time of development is prolonged when capsule-assimilation is hindered by involucral leaves or large calyptra. 8. The length of the seta has a certain amount of influence on the time of development. Shorter setæ can shorten the time of sporogonial development.

Spore Mother-cells of Catharinæa.*—C. E. Allen describes the four-lobed spore mother-cells of *Catharinæa*. This lobing is almost universal in the Jungermanniales, but does not seem to have been noted in the Bryales. Allen also notes the occurrence of a plastid in each lobe of the spore mother-cell. He finds that the differences in size of spore mother-cells of plants collected in different localities are rather striking; yet the mother-cells borne in a single capsule differ little in size, and those of different plants growing in the same clump vary but little in size. Along with these differences in size of spore mother-cells of plants from different localities there are other well-marked differences, such as size of plant, size of leaf, number of lamellæ on the upper surface of the leaves, and number of spines on the lower surfaces. Some of these characters may be influenced by external conditions, but possibly the plants in question may represent distinct races, included perhaps within the limits of *C. angustata*, or some perhaps merging into *C. undulata*.

Pleurozygodon sibiricum.†—I. Györffy criticizes the views of Arnell on this species. The latter held that it was most closely allied

* Amer. Journ. Bot., iii. (1916) pp. 456–60. See also Bryologist, xx. (1917) pp. 64–6.

† Arkiv. f. Bot., xiv. (1915) pp. 1–3 (1 pl.).

to *Anœctangium compactum*, while Györffy, who has examined the original specimen, maintains that it is identical with *Molendoa Sendtneriana.* Anatomical and morphological details are shown on a plate.

Mosses of Amboina.*—V. F. Brotherus publishes an account of the Mosses of Amboina, based on the collections of the ill-fated Dr. C. B. Robinson, together with species gathered by earlier authors, such as Zippel, Naumann, De Vriese, and Micholitz. The enumeration contains sixty-five species, including four new species. Had Robinson been able to complete his exploration, the list would doubtless have contained many more novelties.

Thallophyta.

Algæ.

(By Mrs. E. S. Gepp.)

Crossing of One-celled Haploid Organisms.†—A. Pascher describes the crossing of two different species of *Chlamydomonas* which were not identical with any known species. No. I. was narrowly ovate, with lateral chromatophore and pyrenoid, long cilia, naked gametes, and a roughly sculptured zygote, star-shaped in section, without surrounding coats. No. II. was almost globular, with basal chromatophore and pyrenoid, short cilia, gametes covered with a membrane, and zygotes smooth and surrounded by several coats. Eighty copulations were observed. As regards sculpture, the zygotes stood midway between I. and II., having some surrounding coats, but fewer than in II. Union of the nuclei took place. Cultures were raised from eight of the heterozygotes, five of which merely reproduced the parents ; two of the swarm-spores of each represented I., and two II. The relations of the two classes changed more and more from representing an equal number of both types to a preponderance of type II., caused by the quicker process of division in type II. Type I. takes seventy-two to seventy-six hours, type II. takes forty to forty-five hours to divide. In the three other heterozygotes, four types appeared, namely, one which was very closely allied to I. ; two intermediate forms, and a type which was like II. In the two other cultures, four intermediates were formed. It is to be supposed that each swarm-spore produces a type. In reduction-division a new combination of characters must, therefore, take place. A fuller account will be published later.

Dinoflagellates as Originators of Red Snow.‡—O. Suchlandt controverts the statement of M. Traunsteiner that Peridinieæ are the sole cause of red snow. At the end of December, 1915, an enormous quantity of *Glenodinium* was observed on the ice at Davos See which

* Philippine Journ. Sci., Bot., xii. (1917) pp. 73–80.

† Ber. Deutsch. Bot. Gesell., xxxiv. (1916) pp. 228–42 (5 figs.). See also Bot. Centralbl., cxxxiv. (1917) pp. 36–7.

‡ Ber. Deutsch. Bot. Gesell., xxxiv. (1916) pp. 242–6 (1 pl. and 1 fig.). See also Bot. Centralbl., cxxxiv. (1917) p. 11.

was not identical with the organism described by Traunsteiner. A thaw partially melted the top snow, and renewed frost covered this with a second ice-sheet. Frozen into this were found large curves of greenish-red algæ, 10 m. long, 20 cm. broad, and 7 cm. thick. The frozen colonies were frothy in character. The author describes the Dinoflagellate as a new species, *Glenodinium Pascheri*. The external form and special morphology of the various stages are figured. Further physiological investigations are being made.

Chromulina Rosanoffii.*—J. Buder records having found this alga, which was described as a rare one by Miyoshi, growing on clear sheets of water in all the German mountains of medium height. At certain seasons it is of very frequent occurrence. He describes the origin of the characteristic glitter of the alga, according to Woronin (1880) and Molisch (1901). It is to be explained in the same way as the brilliance of the moss *Schistostega osmundacea*.

Coccolithophoridæ.†—J. Schiller describes the present state of our knowledge of the Coccolithophoridæ. They are coloured flagellates, the body of which is composed of a calcified shell formed of separate calcified plates. The author describes the external form, cell-membrane, protoplasm, chromatophores, vacuole, and shell-structure of these organisms. Their manifold shape is shown in ten figures. The Coccolithophoridæ reproduce themselves by the formation of swarm-spores, in which the tetraspore appears to predominate. The author has also observed the formation of resting spores. Observations are made on the capture and preservation of Coccolithophoridæ. The ecology of the group is only known in its rough outlines. Although they are recorded from all seas, they have only so far been studied from the Atlantic and the Mediterranean. On the voyage of the "Deutschland" Lohmann found the Coccolithophoridæ, together with the Diatoms, the commonest of the plants in the region traversed, and when, in the tropics, the diatoms became less frequent, the Coccolithophoridæ occupied the first place in the phytoplankton.

Plankton of the Swedish Expedition to Spitzbergen, 1908.‡—H. Broch reports on the plankton of the Eisfjord during the summer of 1908, collected by the Swedish Expedition to Spitzbergen. This is the first time that the plankton of a fjord in the high arctic regions has been thoroughly worked out. Arctic-neritic species predominate. Widely distributed are: *Dinobryon pellucidum*, *Goniodoma Ostenfeldi*, *Peridinium brevipes*, *P. curvipes*, *P. islandicum*, *P. monacanthus*, *P. pellucidum*. Among the commonest of the arctic-oceanic species is *Ceratium arcticum*. Many of the boreal species have a partially southern character, such as *Dinophysis acuta*, *Peridinium depressum*, *P. ovatum*,

* Naturw. Wochenschr., n.f. xv. (1916) pp. 94–5 (2 figs.). See also Bot. Centralbl., cxxxiv. (1917) pp. 10–11.

† Die Naturw., iv. (1916) pp. 277–83 (figs.). See also Bot. Centralbl., cxxxiv. (1917) p. 25.

‡ Vet.-Ak. Handl. Stockholm, xlv. (1910) pp. 25–67 (1 map and figs.). See also Bot. Centralbl., cxxxiv. (1917) pp. 53–4.

P. pallidum. The usual diatoms of the arctic summer plankton were not present, except *Chætoceras decipiens.* Perhaps the autumn wave of arctic plankton, with *C. constrictum* and *C. Willei*, moves up from the south into the fjord. The horizontal distribution of organisms in the Eisfjord seems to be uniform. A regular vertical distribution of organisms could not be proved, which is the more remarkable as the water consists almost everywhere of three layers of temperature. In the systematic portion, *Rhizosolenia færoensis* and *R. styliformis* are here recorded, having only been known hitherto from more southerly waters. In all, eleven species of Diatoms, two Flagellates and twenty-eight Peridinieæ are recorded, including three new species of Peridinieæ. The author considers that the relation of the plates in *Peridinium* furnishes a stable character for identification, which holds good in all variations and conditions of growth. Breadth increases more quickly than length, and the *Peridinium* cell becomes flatter during growth.

Nuclear Division in Euglena.*—J. Karl writes on the nuclear division of the Euglenæ of the *viridis* type. He finds that in the nucleus there is a centriolum; and nuclear division begins with the division of this body. The outer nuclear substance arranges itself in filaments or chromosomes, which at first take the form of a net, but soon lie parallel to one another. The chromosomes divide in half longitudinally. Some time later the filaments form once more a nuclear structure. The nuclear division of the Euglenæ may therefore be regarded as a kind of mitosis. The paper is written in Magyar with a résumé in German.

Deposits of Calciferous Algæ in Lake Constance.†—E. Baumann writes on the calcified strata in the Untersee, Lake Constance—namely, the so-called tufaceous limestone deposits and the "Schnegglisande." The former consists of a loose stratum of flint covered with a thick crust of lime. On it are often clumps of *Calothrix parietina*, *Rivularia hæmatites*, *R. Biasolettiana*, etc. These algæ deposit lime from the $CaCO_3$ extracted from the water. The tufaceous limestone is found in places with a swift current, for example, in the Bay of Constance, and in the Rhine up to Gottlieben, especially at Hemmishofen. Much more important is the second formation, the "Schnegglisande." It consists of lenticular, compressed, often hollowed, greenish lumps, strongly incrusted with lime, which are piled up several metres high on the lake bottom. On these occur *Schizothrix lateritia*, *S. lyngbyaca*, *S. fasciculata*, *Hyellococcus niger*, *Plectonema terebrans*, and *Gongrosira codiolifera.* In summer these algæ bind the chalk loosely together in a zone of incrustation. In winter growth is checked. As many as twenty annual rings have been counted. The algæ of the "Schnegglisande" have, with their enormous deposits since post-glacial times, taken an important part in the gradual filling up of the basin of the Untersee.

* Bot. Közlem., xiv. (1915) pp. 135–44 (figs. in text). See also Bot. Centralbl., cxxxii. (1916) p. 504.

† Verh. Schweiz. Naturf. Gesell., 96 Jahresvers. Aargau: (1914) II. Teil. pp. 207–10. See also Bot. Centralbl., cxxxiv. (1917) p. 53.

Algal Flora around Greifswald.*—M. Schultz publishes the second part of the account of the algal flora of the environs of Greifswald which is being worked out by Schütt and his pupils. The first part was published by Wilczek in 1913. The region concerned lies between 13° 2′ and 13° 5′ E. long. of Greenwich, and between 54° 6′ and 54° 9′ N. lat., and is especially interesting on account of its purely fresh-water and purely salt-water pools, as well as every conceivable transition between them. The author proves that the whole southern part of the region, the Ryck-Torfmoor, is distinguished by brackish water, as A. von Chamisso had already conjectured. Since the region belongs to the level lower Pommeranian littoral, the watershed has an extraordinarily slight gradient. The differing salinities of the waters determine in a marked degree the habit of the algal flora, which depends less on the diversity of the species than on the frequency of their occurrence. Specially striking is the capacity of the fresh-water algæ for accommodating themselves to the brackish water. Only a few families were found to occur exclusively in fresh water. Characteristic of the brackish water were species of *Enteromorpha*, *Vaucheria*, *Cladophora*, *Rhizoclonium*, together with a few species of *Spirogyra*, *Zygnema* and *Mougeotia*. And in peaty pools with a salinity of 4 p.c. were flourishing some species of the fresh-water genera—*Œdogonium*, *Ulothrix*, *Aphanothece* and *Tolypothrix*, *Oscillatoria*, *Spirulina* and *Lyngbya*. As to the Diatoms they flourish for the most part equally well in both fresh and brackish water, and pass easily from one to the other. Characteristic of fresh water are a number of forms, including *Volvox*, *Eudorina*, *Pandorina*, *Gonium*, *Stigeoclonium*, *Draparnaldia*, *Zygnema*, *Mougeotia*, *Spirogyra* and all the Confervæ, also the Characeæ. The slight occurrence of *Oscillatoria* and *Lyngbya* seems due to the absence of organic matter. The seasonal distribution of the forms is described. The systematic enumeration contains thirty-six Schizophyceæ, five Flagellata, one hundred and forty-one Diatomaceæ, seventy-eight Chlorophyceæ, one of the Florideæ, two Peridinieæ, and nine Characeæ.

Algal Flora around Greifswald.†—J. Klemm publishes the third part of the account of the algal flora of Greifswald which is being worked out by Schütt and his pupils. The region in question lies between 13° 5′ and 13° 8′ E. long. and 54° 6′ and 54° 8′ N. lat. Coast-land is included, containing areas of brackish water. The subject is treated in considerable detail. As regards the land flora, the author finds that in January and February no growth takes place. March and April are the season of maximum growth of Flagellates, and the spring maximum of Diatoms and certain Chlorophyceæ, notably, *Spirogyra*, *Zygnema*, *Conferva*, *Ulothrix*. In May begins the time for the greatest number of species to occur. In June to August the following reach their maximum: Desmidiaceæ, Protococcoideæ and

* Beiträge zu einer Algenflora der Umgebung von Greifswald. Dissertation. Greifswald: (1914) 77 pp. (1 map). See also Bot. Centralbl., cxxxii. (1916) pp. 471–2.

† Beiträge zu einer Algenflora der Umgegend von Greifswald (südostlich von Neuenkirchen). Dissertation. Greifswald: (1914) 87 pp. (1 pl.). See also Bot. Centralbl., cxxxii. (1916) pp. 456–7.

Confervoideæ (*Enteromorpha*, *Œdogonium*, *Chætophora*, *Cladophora*, *Vaucheria*). In September occurs another maximum of Diatoms, and, under favourable conditions, also of certain Chlorophyceæ (*Spirogyra*, *Mougeotia*, *Conferva*, *Ulothrix*). At the end of October, or at the latest in November, begins the final retrogression of all classes of algæ. As regards the flora of the "Danish Creek" (Dänische Wiek), Chlorophyceæ and Rhodophyceæ constitute the largest proportion; Schizophyceæ and Phæophyceæ are very much fewer. The maximum occurs from June to September. At no time, however, is there an entire lack of algæ. The Characeæ form a typical coast flora, which is explained by the low salinity. The Rhodophyceæ grow luxuriantly. The Phytoplankton is represented by Schizophyceæ (6), Silicoflagellatæ (1), Peridinieæ (2), Diatoms (74), and Chlorophyceæ (4). The quantitative results are set forth in tabular form. The Diatoms attain their maximum in April, the principal genera being *Chætoceras*, *Diatoma*, *Fragilaria*, *Synedra*, *Cocconeis*, *Rhoicosphenia*, *Navicula*, *Epithemia*, *Nitzschia*. Only in April are found *Sceletonema* and the Silicoflagellate *Ebria*. *Scenedesmus* is especially abundant in April. Schizophyceæ and Chlorophyceæ appear first in July and reach their maximum in September and October. *Anabæna* has its maximum in August. This paper shows, by comparison with the work of Abshagen on the Dänische Wiek some years ago, that both qualitatively and quantitatively the composition of the plankton has altered considerably, especially in the Schizophyceæ, Chlorophyceæ and Diatoms. A systematic list of all the species recorded in the region is given, with references to literature and critical notes; as well as tables to show their frequency.

Flora of Great Salt Lake of Utah.*—L. L. Daniels reports on the flora of the Great Salt Lake and the effect, on the organisms, of different densities of the water. He gives first a short summary of previous work on the Salt Lake flora, which appears, like the fauna, to be abundant in individuals, but not in species. The observations made covered a small portion of the southern end of the lake at what is known as Saltair Beach. This is at such a distance from any stream entering the lake that the density of the water there is not affected to any degree. Among the algæ found there was a species of *Chlamydomonas* which N. L. Gardner believes to be a new species. It has a rich green colour, and occurs, during the warm weather, on the surface of the water in many more protected places. Another species is *Aphanothece Packardii* (Farlow) Setchell, which occurs in small masses, irregular in size, floating in the water and piled up by the waves on shore. Microscopic examination of this material shows the individual plants in a mature condition, and also in various stages of division by fission. Two species of diatoms were found, belonging probably to *Navicula* and *Cymbella*. As regards the physiological investigations the results obtained show that variations in density of the water of Great Salt Lake cause no corresponding variations in the size of *Chlamydomonas* cells. The indication is that water somewhat less dense than that normally

* Amer. Nat., li. (1917) pp. 499–506.

present in the lake, at its present level, is most favourable to the development of *Chlamydomonas* sp. The diatoms present in the lake multiply best in water much less dense than the dense water at Saltair. At least four species of algæ are to be found in the part of the lake investigated.

Algæ of Traunstein and the Chiemgau.*—E. Kaiser publishes the third part of his Algal Flora of Traunstein and the Chiemgau, which contains 129 records of species and varieties. Some of these are new to Bavaria. The groups treated are Schizophyceæ, Zygophyceæ, Conjugatæ, and Chlorophyceæ. A list of the more important species recorded is given in the "Botanisches Centralblatt."

Chlorophyceæ of Central Europe.†—W. Heering publishes a part of the "Süsswasser Flora Deutschlands, Oesterreichs und der Schweiz," in which he deals with Ulotrichales, Microsporales, and Œdogoniales. A key is given first to all the filamentous green algæ, including also Siphonales and Siphonocladiales. The treatment of the groups corresponds with that followed in the other parts of the work already published.

Danish Aërophilous Algæ.‡—J. B. Petersen publishes the results of his studies on the Danish aërophilous algæ, and describes his experiments to grow them in culture. He treats of their power to resist desiccation, and confirms the results of Schroeder (1886) and F. Gay (1891). The diatoms are specially discussed, and new species described. The mode of life and methods of culture of certain Chlorophyceæ are described in detail.

Position of Chromatophores in Red Algæ.§—G. Senn discusses the position of the chromatophores in the palisade cells of *Peyssonelia Squamaria* and *Platoma cyclocolpa*. In diffused light of medium intensity they are arranged in antistrophe on the portions of the membrane turned towards the source of light. By illuminating the lower surface of the *Peyssonelia* thallus, the chromatophores were forced to collect in the opposite ends of the cells, which, though anatomically on the underside of the thallus, were the most brilliantly illuminated. By prolonged darkening of the cells of *Platoma*, apostrophe of the chromatophore was produced; by intensive illumination, parastrophe. The difference between the arrangement of the chromatophores in the palisade cells of marine algæ (antistrophe) and of foliage leaves (epistrophe) in optimal-diffuse light is to be explained by the difference of the optical conditions. If these conditions are equalized by the injection of water into the air-containing intercellular spaces which in foliage leaves cause the reflection of the light-rays which penetrate into the palisade cells, it is found that

* Kryptog. Forschungen, Beil. No. 14, iii. Mitt. Bayer. Bot. Gesell., 1916, pp. 30–8. See also Bot. Centralbl., cxxxiv. (1917) p. 25.

† Süsswasser-Flora Deutschlands, Oesterreichs und der Schweiz, Heft 6 (1914) 250 pp. (385 figs.). See also Bot. Centralbl., cxxxiv. (1917) p. 54.

‡ K. Dansk. Vidensk. Selsk. Skrift., xii. (1916) pp. 271–379 (4 pls.). See also Nuova Notarisia, xxviii. (1917) pp. 252–4.

§ Actes Soc. Helvét. Sci. Nat. Genève (1915) pt. 2, p. 203. See also Bot. Centralbl., cxxxii. (1916) p. 505.

antistrophe can be brought about by a convergence of light-rays of 90° and more into the palisade cells of foliage leaves. Thus the same arrangement of the chromatophores is brought about in foliage leaves and in the marine algæ investigated.

Algæ from the Chincha Islands.*—F. S. Collins publishes a list of a small but interesting collection of marine algæ from the Chincha Islands, off the coast of Peru, collected in 1862 by a Mrs. Nickerson, wife of a sea-captain who visited those islands. The algæ in question are preserved in the University of Maine, and consist of twenty-one species, of which five are additional to the known algæ of Peru, and one represents a new form of *Plocamium coccineum*. To many of the records the author adds critical notes.

Hawaiian Algæ.†—Mac C. Vaughan writes on the species of algæ used as food in the Hawaiian Archipelago. The native generic name is Limu; and a specific name is added. The species in question are *Enteromorpha flexuosa*, *Gelidium Amansii*, *Gymnogongrus* sp., *Codium Muelleri*, *Hypnea nidifica*, *and Asparagopsis Sanfordiana*. Species of *Spirogyra* and *Centroceras* are used in the local pharmaceutical preparations.

Chara crinita.‡—A. Ernst publishes his investigations on *Chara crinita*. Since the work of Braun and Migula this species has been regarded as a genuine example of true parthenogenesis in the vegetable kingdom. The author here shows, however, that, in agreement with the results in Angiosperms, there is here no generative, but a somatic, parthenogenesis (ovogenous apogamy).

Fungi.

(By A. Lorrain Smith, F.L.S.)

Protascus subuliformis Dang.§—René Maire describes a new Nematode worm *Rhabditis Giardi*, and with it a fungal parasite *Protascus subuliformis* which was found infecting that and other Nematodes. The life-history of the fungus is followed in detail; it invades every part of the body of the worm through germinating spores which pierce the cuticle by means of ferments and form sporangia with a very varying number of spores; or zygospores are formed which function as resting spores.

Protascus is compared by the author to other similar organisms, and its place discussed in relation to allied fungi. Either, he considers, it should be placed in the family Lagenidiaceæ or should form a separate family Protoascaceæ.

* Rhodora, xvii. (1915) pp. 89–96.
† Amer. Journ. Bot., iii. (1916) pp. 474–9. See also Nuova Notarisia, xxviii. (1917) p. 252.
‡ Actes Soc. Helvét. Sci. Nat. Genève (1915) pt. 2, p. 198. See also Bot. Centralbl., cxxxii. (1916) p. 504.
§ Bull. Soc. Hist. Nat. Afrique du Nord, vii. (1915) pp. 33–51 (13 figs.).

Use of Brewer's Yeast in Bread-making.*—Julian L. Baker has discussed the possibility of utilizing brewer's yeast in case distiller's yeast should not be available. The main advantages of the latter are the shorter time necessary for the fermentation of the dough, and its toxin immunity. The same yeast species, *Saccharomyces Cerevisiæ*, is the organism in both yeasts.

From the experiments carried out, it has been proved that an equal blend of the two yeasts gives satisfactory results, and that brewer's yeast alone would produce palatable loaves if "slow-doughing" were practised.

Laboulbeniæ of North Africa.†—René Maire had already published a number of these insect fungi which occurred in North Africa; since that publication other lists have been issued, and he now gives a complete account of all that are known from that region. They number fifty-five different species, most of them already known and described, though several species are new to science, as are two genera *Bordea* and *Peyerimhoffiella*; the former akin to *Stigmatomyces*, the latter to *Laboulbenia*. The insect hosts and their habitat are described in each case.

A further contribution ‡ on the subject contains additions to the North African list and the description of a new species.

A new species,§ also from Algiers, *Rickia Peyerimhoffii*, is described. It is interesting as occurring on a specimen of *Scaphosoma agaricinum*, and is the only instance recorded of a *Laboulbenia* on *Scaphidiidæ*. It came from marshy forests in North Africa where humidity is constant even in summer.

Development of Alternaria Solani.‖—R. D. Rands explains his method of securing sporulation from cultures of this fungus, the object being to secure spores for inoculation experiments. The scarcity of spores in pure cultures had been noted by various writers. Various changes in humidity and temperature were tried without result, until the culture-agar was shredded and the mycelium severely wounded in connexion with vapour tension in the air.

Vertical Distribution of Fusarium.¶—As the damping-off of seedlings of *Pinus* had been causing trouble in the garden of Brown University, Rhode Island, Minnie W. Taylor has examined the depth to which *Fusarium* may penetrate the soil. Previous records only gave a penetration of seven inches. But by cultures of soils taken at varying depths, *Fusarium* which causes the damping-off was found in the nursery at twenty-four inches and all intervening depths. In grassland it was found only at two, three, and twenty inches. There is also some evidence of seasonal variation, as it was more abundant in the cultures taken in March than in the previous winter months.

* Journ. Inst. Brewing, xxiii. (1917) pp. 372–82.
† Bull. Soc. Hist. Nat Afrique du Nord, vii. (1916) pp. 6–39 (2 pls. and 4 figs.).
‡ Bull. Soc. Hist. Nat. Afrique du Nord, vii. (1916) pp. 100-4 (1 fig.).
§ Bull. Soc. Fr. Belg., xlix. (1916) pp. 290–6 (6 figs.).
‖ Phytopathology, vii. (1917) pp. 316–17 (1 fig.).
¶ Phytopathology, vii. (1917) pp. 374–8.

Uredineæ.*—W. H. Long describes a series of *Ravenelia* species collected by him in Texas, several of them new to science. Biological notes are added, and *Ravenelia* galls are described and compared in two species ; in both there is a leaf and a gall form, teleutospores usually occurring on leaves, while on the galls are found only uredospores.

J. C. Arthur † reports on his cultures of Uredineæ in 1916 and 1917. There are seven successful cultures in 1916 of *Puccinia*, the teleutospores of which have been sown on the alternate hosts. All of these had been previously reported. In addition, *Uromyces Sporoboli* æcidiospores from *Allium stellatum* were sown on *Sporobolus vaginæflorus*, and the teleutospores on *Puccinia Vernoniæ* were sown on the same host. Both cultures were successful.

For the year 1917 four successful cultures of *Puccinia* and *Uromyces* are confirmed, while two new cultures are reported : *Puccinia Sporoboli* teleutospores successfully sown on *Allium cernuum*, *A. Nuttallii*, and *Lilium umbellatum*, while *Uromyces magnatus* teleutospores from *Spartina Michauxiana* produced æcidia on *Polygonatum biflorum*, *P. commutatum*, and *Vagnera stellata*.

H. S. Jackson ‡ reports two new forest rusts from North-west America : *Chrysomyxa Weirii* on *Picea Engelmanii* and *Melampsora occidentalis*, the teleutospores of which grow on various *Populus* trees.

With reference to the dispersal of *Cronartium ribicola*, G. F. Gravatt and Rush P. Marshall § find that various small animals act as the bearers of the spores, which adhere to the bodies of the animals. The animals feed on the spores, remains of which have been found in their excreta. It was also proved that alimentation had lessened the vitality of the spores.

Parasitism of Ustilago Zeæ.‖— F. J. Piemeisel has studied, by means of inoculation experiments, the occurrence and life-history of this fungus which occurs on the leaves, ears, etc., of the host-plant. As a plant may be affected at different areas while neighbouring plants are free, it was surmised that the disease might travel to different parts of the plant within the tissues. This, however, as already pointed out by Brefeld, is not the case, attacks being due to repeated infection. Any injury to the host-plants, such as close planting, very early and very late planting, are all conducive to disease. Vigorously growing plants, between two and three feet high, are very susceptible to attack. The spores of the fungus may germinate as soon as mature, but they retain their viability for a number of years (at least five years). They are killed, however, after having been kept in a silo for a few weeks, owing probably to the presence of silage acids. Sporidia which were produced from the germinating spores are almost as resistant as the spores, and are not much injured either by desiccation or by freezing.

* Bot. Gaz., lxiv. (1917) pp. 57–69.
† Mycologia, ix. (1917) pp. 294–303.
‡ Phytopathology, vii. (1917) pp. 352–5.
§ Phytopathology, vii. (1917) pp. 368–73.
‖ Phytopathology, vii. (1917) pp. 294–307.

American Fungi.*—W. A. Murrill publishes a plate of coloured drawings of the larger fungi, with descriptions, all of them, with one exception, also to be found in this country. They include such familiar species as *Cantharellus cibarius*, *Collybia dryophila*, *Mycena pura*, etc.

Homer D. House † gives an account of a series of models of fungi, the work of an artist and sculptor, Henri Marchand. They are made of wax, and have been placed in the State Museum at Albany, New York, as a memorial to the late Charles Horton Peck.

Development of Basidiocarps in Pholiota.‡—W. H. Sawyer has made a comparative study of the three species *Pholiota squarrosa*, *P. flammans*, and *P. adiposa*. He describes the origin of the primordia of the different parts, pileus, hymenophore, etc., the growth of the outer coverings and of the gills. There are distinct differences in the mode and extent of development of the various parts in the species examined. The paper is illustrated by microphotographs.

New or Rare Species of Gasteromycetes.§—W. H. Long describes some fungi of this group from Texas:—*Geasteroides* gen. n., in which the exoperidium splits into reflexed persistent segments, while the endoperidium is more or less deciduous; *Arachniopsis* gen. n., also with a double peridium, the outer fragile and more or less deciduous, the inner cartilaginous and opening irregularly at the apex; both genera are represented by one species. The author further describes species of *Lysurus* and *Laternea*, both previously known to science.

Chemical Research on "Elaphomyces hirtus."‖—Giovanni Issoglio has chemically tested every part of the fruiting body of this fungus, of which he gives a qualitative and quantitative analysis of the water, ash, etc. He then records the results of examination by extract—micosterina obtained from the peridium is a carbohydrate. Minute quantities of alkaloids were determined; they were not sufficient to be analysed. Mannite, which is generally diffused in fungi, was also found in the peridium and in the gleba. From the hyphæ was extracted a carbohydrate, micoinulina, and another substance, paraiso-destrano, previously discovered by Winterstein in *Polyporus betulinus*. Fungus cellulose, termed here "Fungina," was examined and found to contain a certain amount of nitrogen. The brown pigment of the spores was also found to contain nitrogen. A preface to the paper is supplied by Mattirolo.

Australian Fungi.¶—J. Burton Cleland and E. Cheel are continuing their study of these fungi, and contribute notes on Nidulariaceæ and Lycoperdaceæ. In the former family the two genera *Cyathus* and

* Mycologia, ix. (1917) pp. 257–60 (1 pl.).
† Mycologia, ix. (1917) pp. 313–14.
‡ Bot. Gaz., lxiv. (1917) pp. 206–29 (5 pls.).
§ Mycologia, ix. (1917) pp. 271–4.
‖ Atti Reale Accad. Sci. Torine, lii. (1917) pp. 644–62.
¶ Journn. and Proc. Roy. Soc. N.S. Wales, l. (1916) pp. 105–29.

Crucibulum are both represented; to the latter belong the genera *Podaxon*, *Tylostoma*, *Chlamydopus*, *Phellorina*, *Battarrea*, *Polysaccum*, *Scleroderma*, *Geaster*, *Mycenastrum*, *Catastoma*, *Bovistella*, *Lycoperda*, *Calvatia* and *Mitremyces*—a very large representation of this family, since many of the genera are confined to the warmer regions of the globe. Descriptions both historical and biological are given.

Sexuality of the Basidiomycetes.*—Matilde Bensaude has studied the origin of binucleate cells in this group of fungi by means of cultures. She finds that on sowing spores of *Coprinus* there results a primitive mycelium uninucleate and without clamp connexions; anastomosis frequently occurs, but if the origin of the mycelium is from one spore only the character of the hyphæ never changes. If the culture is from mixed spores of *Coprinus*, anastomosis and fusions again take place, but clamp connexions are also formed and the binucleate condition appears. This arises on conjugation of the mycelium of different origin which, following Blakeslee, she designates as + or − ; the formation of clamp connexions follows, and is a sure indication that conjugation has taken place, the prelude of further fructification.

Bulbiferous Fungi.†—J. W. Hotson has made a study of all the known forms of bulbils as a form of reproduction in fungi. They are associated with very varied fungi, both Ascomycetes and Basidiomycetes, but as they bear a general resemblance to each other in structure and in germination, they have been classified under the form genus *Papulospora*. The bulbil is derived from a group of initial cells to which new ones are added by a process of germination. Mature bulbils may resemble sclerotia, but these latter are formed by the massing together of vegetative hyphæ. In all cases bulbils are imperfect conditions of higher fungi, though it seems to be impossible by cultures to enable them to revert to the higher form. A synoptic key of the various species is given.

Poisonous Fungi of Algiers.‡—René Maire has made a special study of these poisonous fungi in Algiers; they are identical with those found in Europe and cause the same accidents. They belong to five genera—*Amanita*, *Volvaria*, *Entoloma*, *Lepiota* and *Clitocybe*—and the species are exhaustively described. Cases of poisoning are described and remedies are recommended.

North African Fungi.§—René Maire is studying the fungi of North Africa generally. A list of those found in Tunisia comprises microfungi with few exceptions. Most of them are European; a few are new species.

Another list ‖ deals with the fungi in or near Algiers, also most of them more or less familiar species. A new variety of *Boletus erythropus* is described and figured, and several new species of microfungi. In a

* Comptes Rendus, clxv. (1917) pp. 286–9.
† Bot. Gaz., lxiv. (1917) pp. 264–84 (3 pls. and 6 figs.).
‡ Bull. Soc. Hist. Nat. Afrique du Nord, vii. (1916) pp. 131–206.
§ Bull. Soc. Hist. Nat., vi. (1914) pp. 254–60 (3 figs.).
‖ Bull. Soc. Hist. Nat., vii. (1916) pp. 294–303 (1 pl.).

continuation of the list[*] a long account is given of *Sphacelotheca polygoni-serrulati* sp. n., which destroys the ovaries of the host-plant, resembling thus *S. hydropiperis*, but whereas the spores of the latter germinate only after a resting stage of six months, those of the new species germinate at once in water. Another new species, *Nectria pyrosphæra*, which grows on rotten wood, is distinguished by the fine striations on the spores.

Economic Mycology.[†]—M. C. Potter emphasizes the need for wide attention being paid to the pathology of plants both in our own country and in the Colonies. He desires the establishment of more centres for the study of plant hygiene as well as plant pathology, and the encouragement of workers in this branch of science.

Effects of Dyes on Endothia parasitica.[‡]—Caroline Rumbold records the results obtained by growing conidia and mycelium of the fungus in nutrient media to which was added Congo-red, trypan-blue, or methylene-blue, in very dilute quantities. In the Congo-red culture the hyphæ became red-coloured, but developed normally, producing pycnidia and conidia; the latter from the pycnidia were colourless. The medium lost its colour as growth proceeded. In trypan-blue the conidia stained a deep blue; growth was normal, and the blue colour of the hyphæ deepened with age, the medium losing colour. The culture with methylene-blue was less successful. Special attention was given to the storage of the colouring-matter by the fungus, and to the effects on reagents on it.

Vitality of Fungus Spores.[§]—Louis Rénon comments on the resistance to desiccation of the spores of *Aspergillus fumigatus*. He had proved them to be alive in a neglected culture after four years, though in cultures carried on for three or four years the vegetative as well as the harmful power declined. The writer then gives an account of the finding of a culture tube containing *Aspergillus fumigatus* spores dating from 1892. He sowed the spores on a suitable medium, but they failed to grow. He then inoculated two rabbits with sufficient material to have killed them, without any effect being produced. In the twenty-five years that had elapsed the spores had completely lost vitality and virulence.

Methods of Differentiating Fungi in Host-cells.[‖]—C. S. Ridgway has found a useful method in the employment of methylene-blue as a first stain followed by eosin in clove-oil. He explains in detail the necessary steps to ensure successful results. The double staining process has been found effective in connexion with *Botrytis* and *Rhizopus* in strawberry fruits, *Pythium* in potato tubers, *Fusarium* in tobacco stems, and crown rust in *Rhamnus cathartica*.

* Bull. Soc. Hist. Nat., viii. (1917) pp. 74–83 (4 figs.).
† Journ. Roy. Hort. Soc., xlii. (1917) pp. 317–23.
‡ Bot. Gaz. lxiv. (1917) pp. 250–2.
§ C.R. Soc. Biol. Paris, lxxx. (1917) pp. 616–17.
‖ Phytopathology, vii. (1917) pp. 389–91.

Mycological Notes.*—W. B. Grove continues his notes on new or rare species, with an account of various microfungi. *Amphichæta europæa*, a new genus for Britain, though the species was collected by Berkeley in 1857. Another species, *Epochnium macrosporoideum* Cooke, was placed by Saccardo in *Stemphylium*, and is now again recorded. Other species are recorded and commented on.

Spanish Microfungi.†—Romualdo Gonsalez Fragosa has published a complete list up to date of the microfungi observed by himself and by other workers in the province of Cataluna. In the preface he enumerates these other workers, and explains his method of compiling the lists, pointing out the advantage and necessity of giving the locality as well as the substratum or host of each species. In all 307 species are listed, a few of them being new to science.

Diseases of Plants.‡—The "blossom-wilt and canker" disease of apple-trees has been described by H. Wormald. It is caused by the fungus *Monilia cinerea*, and has caused great loss in some districts. The first evident symptoms of the disease is the blossom-wilt condition; the flowering stalks begin to wilt and are frequently killed. The more serious canker condition follows through the penetration of the fungus into the deeper tissues of the branches. It was found that the spores of *Monilia cinerea* germinated in a few hours. When germinated on the stigmas of the flowers the tube travelled down the styles to the centre of the flower, then along the flower-stalk into the spur; wilting of the leaves occurred about a fortnight after infection. Methods of controlling or eradicating the disease are suggested.

W. H. Martin § has established the identity of *Sclerotium bataticola*, a parasite of sweet-potato, with a similar parasite of pepper. On breaking open the fruits numerous small black sclerotia were found in the interior and also on the seed. Cultures were made and inoculation experiments were undertaken, which were uniformly successful on a broken or wounded surface. A number of different plants were thus infected with the parasite.

Mel. T. Cook ‖ found a disease of Norway maples to be due to a *Nectria*; the dead branches had been girdled by a canker, and the older cankers were covered with *Tubercularia* pustules, a stage in the life-history of *Nectria*. Infection takes place by wounds, and the *Nectria* is chiefly saprophytic, though it becomes parasitic when it gains entrance to the tissues.

Damping-off of tomatoes has been traced by J. E. Howitt ¶ to an attack of *Phytophthora infestans* on the stems near the surface of the

* Journ. Bot., lv. (1917) pp. 134–6 (2 figs.).

† Musei Barcin. Sci. Nat. Opera Ser. Bot. Barcelona, ii. (1917) 187 pp. (1 pl. and 22 figs.).

‡ Journ. Board Agric., xxiv. (1917) pp. 504–13 (4 pls.).

§ Phytopathology, vii. (1917) pp. 308–12 (10 figs.).

‖ Phytopathology, vii. (1917) pp. 313–14.

¶ Phytopathology, vii. (1917) p. 319.

ground. The falling over of the plants by hundreds in the field first drew attention to the presence of the disease.

W. Nowell * writes on root-diseases due to *Rosellinia* in the West Indies, generally in those islands with a damp climate. *R. pepo* occurs on cacao, and is transmitted from several shade trees. The disease on limes and coffee may be due to either *R. pepo* or *R. bunodes*. An infested tree may be killed by the gradual investment of the roots, or more quickly by the fungus attacking the bark around the collar.

J. Elliot † publishes the results of his study of "soil-rot" of *Batatas*. The disease is due to a plasmodium, and he has observed two modes of infection: one by the plasmodium as a whole causing large shallow pits; the other by means of swarm-spores developed within thick-walled cysts. The formation of the cyst distinguishes this plasmodium from other allied genera, accordingly the name *Cystopora batata* g. et. sp. n. is given to it.

F. A. Wolf ‡ records the attack of *Cucurbita* by the fungus *Choanephora cucurbitarum*. It has done great damage, causing a blight of the flowers and a rot of the fruits. The sporangia, chlamydospore, and zygospore stages of the fungus have been produced in artificial cultures. The fungus is widely spread in America.

A disease of *Nymphæa* in the United States has been found by F. V. Rand § to be due to *Helicosporium nymphearum* sp. n., which causes olive-black spots on the leaves. It gains entrance by the stomata, and the mycelium ramifies in the intercellular spaces and between the cells. The contents of the cells become coagulated and the nuclei and chlorophyll bodies disintegrate. Spraying with Bordeaux mixture was beneficial.

René Maire ‖ has described some diseases of trees in North Africa. On *Arbutus Unedo* he discovered a new fungus, *Exobasidium Unedonis*, which gives rise to witch's-brooms. The fungus attacks the leaves and the young shoots. Associated with *Exobasidium* he found *Glœosporium conviva* sp. n. on the twigs and leaves, where it forms white pustules, and *Phoma Arbriti*, which appears on the shoots killed by the *Exobasidium*. A new *Phragmidium* on *Rosa sempervivens* covers the leaves with yellow pustules and the branches with black ulcerations. It is common in Algiers.

A disease of potatoes called "black-leg" ¶ or "black-stem" rot is due to the presence of *Bacillus phytophthora*. It appears quite early in the

* W.I. Bull. Barbados, xvi. (1916) pp. 31–71 (figs. 1–12). See also Bull. Agric. Intell. Rome, viii. (1917) pp. 940–1.

† Science, xliv. (1917) pp. 709–10. See also Bull. Agric. Intell. Rome, viii. (1917) pp. 943.

‡ Journ. Agric. Research, Washington, vii. (1917) pp. 319–27 (pls. 85–87). See also Bull. Agric. Intell. Rome, viii. (1917) p. 944.

§ Journ. Agric. Research, Washington, viii. (1917) pp. 219–32 (4 pls.). See also Bull. Agric. Intell. Rome, viii. (1917) pp. 945–6.

‖ Bull. Stat. Rech. Forest, Nord Afrique, l. (1916) pp. 121–30 (1 pl. and 4 figs.).

¶ Journ. Board Agric., xxiv. (1917) pp. 653–6 (1 fig.).

year, about the middle of June, and is most severe in wet seasons. The first symptoms are the withering of the leaves and the stunted appearance of the plants, and at the base of the stem the formation of inky-black spots. The disease passes along the rhizomes and enters the tubers. Advice is given as to the control and cure of this disease.

Lucien Daniel * suggests means of combating the oak *Oidium*. The usual method on farms has been to cut back the oak every seven years, and to remove the crown. The result is that numerous short branches are formed. A second method is to decapitate the tree. In that instance the normal balance of growth is upset and the tissues become surcharged with water, which favours the *Oidium*. Daniel recommends the retaining of the crown and branches at the top of the trees as ensuring more free transpiration.

R. O. Cromwell † describes a disease of soy-bean due to the attack of *Fusarium tracheiphilum*, the fungus that causes "cowpea-wilt." Infection probably occurs through the root; the largest percentage of diseased plants appeared in coarse sandy soil.

P. Voglino ‡ has investigated the fungi that causes root-rot of the mulberry in Piedmont, Italy. The trees are stripped of their leaves, every year, and thus weakened and rendered liable to attack. Two fungi are mainly responsible for the rot:—*Armillaria mellea*, which causes the roots to rot and frequently kills the trees, and *Rosellinia necatrix*, the latter, usually found on young planted-out trees. The first symptoms of disease are the yellowing of the leaves. In the case of such rotting of the roots it is advisable not to plant mulberry-trees on the same ground for at least two years.

Melanconium Sacchari has been diagnosed by J. R. Johnston § as the cause of "rind-disease" of sugar-cane which has been reported from many countries. It is a wound parasite which causes eruptions on the rind, with a consequent drying-up of the leaves. Various remedial measures are suggested.

P. Voglino and V. Bongini ‖ describe a disease of chestnuts which appears while they are in storage. It is due to the fungus *Phoma endogena*, which forms a white-felted mycelium on the cotyledons beneath the pericarp. The latter becomes detached owing to the shrinkage of the seed. The pycnidia of the fungus are formed in abundance on the white mycelium on the surface of the cotyledons; they rarely develop on the seed-coat.

* Comptes Rendus, clxiv. (1917) pp. 957–9.

† Journ. Agric. Research, Washington, viii. (1917) pp. 421–40 (1 pl. and 1 fig.). See also Bull. Agric. Intell. Rome, viii. (1917) pp. 1059–60.

‡ Inform. Seriche, Rome, iv. pp. 97–104. See also Bull. Agric. Intell. Rome, viii. (1917) pp. 1060–1.

§ Journ. Agric. Porto Rico, i. (1917) pp. 17–47. See also Bull. Agric. Intell. Rome, viii. (1917) p. 1060.

‖ Ann. Accad. Agric. Turin, lx. (1917) 12 pp. (8 pl. and 3 figs.). See also Bull. Agric. Intell. Rome, viii. (1917) pp. 1062–3.

A disease of *Datura Stramonium* due to a brown mould, *Alternaria crassa*, is described by R. D. Rands.* The leaves are used for the extraction of atropin or daturin, and the presence of the fungus lessens materially the value of the leaves. Many cultures were made to ensure the identity of the fungus, which Rands holds to be synonymous with *Cercospora crassa*, *Macrosporium Solani*, and others.

L. E. Miles † describes a number of fungoid diseases from Porto Rico : a leaf-spot of the bean, due to *Isariopsis griseola* ; *Cercospora*, on tobacco and other plants ; *Pucciniopsis Caricæ*, on the paw-paw, of special interest on account of a curious fungus, *Zygosporium oschioides*, that grows saphrophytically on the *Pucciniopsis* spots, and other leaf forms on the avocado, the yam, and on *Paspalum*.

Wood-destroying Fungi.‡—J. R. Weir gives additional notes on the fungi that attack both coniferous and deciduous trees. They are all forms of Polyporaceæ, except *Schizophyllum commune*, which has been found once on *Tsuga heterophylla*.

Dry-rot of Potatoes.§—G. H. Pethybridge and H. A. Lafferty have examined this rot of potatoes largely with a view of determining the species of *Fusarium* by which it is caused, and which had been described in a previous research on the subject as *F. Solani*, a collective species. Wollenweber had found that rot in potatoes might be caused by eight different species of *Fusarium*, the most virulent being *F. cœruleum*, which has been recorded as British. The authors have investigated eleven distinct cases of the disease, and in every case the organism causing it was *F. cœruleum*. It is essentially a storage disease, and owing to the action of the fungus the potato loses water and shrinks, becoming finally light in weight, dry and hard. Artificial cultures were made, and in most of them the characteristic blue colour, to which the fungus owes its name, was produced.

Infection generally takes place through wounds, but may also occur through scab spots or through the lenticels, eyes, or young sprouts of uninjured tubers. Potatoes become more susceptible to infection as they become more mature.

Disease of Pitch Pine Timber.‖—L. O. Overhots ascribes this disease to the action of *Polyporus amorphus* ; it causes a characteristic decay of the sapwood of *Pinus rigida*, and has also been collected on wood of *Pinus Strobus*, *P. pungens* and *Tsuga canadensis*. The disease was observed on fallen trees in the vicinity of State College, Pennsylvania. The decayed wood became darker in colour, and the spring wood is decayed before the summer wood. The fungus attacks the cellulose of the medullary rays, dissolving it out, then the bordered pits, and finally

* Phytopathology, vii. (1917) pp. 327–37 (4 figs.).
† Phytopathology, vii. (1917) pp. 345–51 (3 figs.).
‡ Phytopathology, vii. (1917) pp. 379–80.
§ Sci. Proc. Roy. Dublin Soc., xv. (1917) pp. 193–222 (2 pls.).
‖ Mycologia, ix. (1917) pp. 261–70 (2 pls.).

the liquified elements. The author conclndes that the younger mycelium produces an enzyme that dissolves cellulose, but that at a later stage more of a lignin-dissolving enzyme is formed.

The sporophores are resupinate or dimidiate. and rhizomorphs of a yellow or light orange colour, about 1 mm. thick, are often abundantly developed.

Lichens.

(By A. Lorrain Smith, F.L.S.)

Jamaica Lichens.*—L. W. Riddle has examined a collection of lichens made in Jamaica by Cushman in 1912. He describes two new species, *Buellia rinodinospora* and *Chiodecton ciostictum*. The latter is identical with one of Wright's Cuban lichens, named by Nylander *Stigmatidium ciostictum* (*nomen nudum*). Riddle found also two new species of *Megalospora*, and has revised the genus.

Lichens of Whatcom County, Washington.†—A. C. Herre publishes a long list of the lichens found by him (124 species), and also an account of the configuration of the county and the climatic conditions. The mean annual rainfall is 31·5 inches, but as one ascends the mountains the rainfall increases, and the lichens are there more abundant and of larger size; but, on the whole, mosses and liverworts are so abundant that the lichen growth is comparatively insignificant. Most of the species listed are familiar European plants. Herre notes that Collemaceæ are very rare.

New or Rare Lichens.‡—W. Watson concludes his series of notes on lichens, the present contribution being mainly devoted to the consideration of *Cladonia* species, mostly collected in Somerset. A number of Pyrenolichens are also recorded, and a new species, *Staurothele ebborensis*, from carboniferous limestone, Mendip, Somerset, is described. The author is somewhat doubtful of its status as a new lichen.

Schizophyta.

Schizomycetes.

Chemistry of Fats of Tubercle Bacilli.§—M. Burger has demonstrated that tubercle bacilli contain "cerolipoids" consisting partly of the homologous fatty acids on the series $C_nH_{2n}0_2$ from lauric to palmitic acids, and partly of high molecular alcohols of the formula $C_nH_{2n-2}O$ ($C_{15}H_2O$, C_1H_3O, and $C_{29}H_{56}O$).

* Bull. Torrey Bot. Club, xliv. (1917) pp. 321–30 (1 pl.).
† Bryologist, xx. (1917) pp. 76–84 (1 fig.).
‡ Journ. Bot., lv. (1917) pp. 310–16.
§ Biochem. Zeitschr., lxxviii. (1916) pp. 155–64. See also Journ. Chem. Soc., i. (1917) p. 499.

Chemical Changes produced by Coli-typhosus Group Bacteria.* — H. Raistrick as the result of his experiments reports that histidine is converted into urocanic acid (β – iminoazolylacrylic acid) in a medium consisting of Ringer's solution and histidine by the following bacteria: *B. coli communis*, *B. typhosus*, *B. paratyphosus*, *B. enteriditis*, and *B. dysenteriæ*. The change is represented by the equation $C_3H_3N_2 . CH_2 . CH(NH_2) . CO_2H = C_3H_3N_2 . CH : CH . CO_2H - NH_3$.

Decomposition of Protein-substances through the Action of Bacteria.† — R. H. Robinson and H. V. Tartar have studied the chemical changes that occur when a protein is acted on by certain organisms — *B. subtilis*, *B. mycoides*, and *B. vulgaris* (*proteus*) — present in most soils. The percentage of nitrogen combined in various forms are estimated before and after bacterial action by Van Slyke's method.

The results indicate that all the forms in which nitrogen is combined are changed, more or less, by the action of bacteria, and the end-product ammonia is formed. The mono-amino-acid nitrogen and diamino-acid nitrogen of the protein are the chief sources of the ammonia produced, but the action of the bacteria is not confined to one particular form to the exclusion of the others. The rapidity of action varies greatly with different proteins, casein showing no further change after a few days, whilst gliadin continues to evolve ammonia after thirty days. The reason for the arrest of bacterial action has not been elucidated; it does not appear to be the formation of a toxic substance.

The changes observed indicate that the bacterial decomposition of proteins is effected by hydrolysis, with the formation of the amino-acids, and subsequent degradation with the liberation of ammonia.

Development of Reproductive Organs in Yeasts.‡ — K. Saito has ascertained the action of various chemical agents on the development of spores by the following three yeasts: *Zygosaccharomycetes manchuricus*, *Schizosaccharomycetes octosporus*, and *Saccharomycetes manchuricus*. The results indicate that the formation of spores only occur when the medium in which the yeast-cell is grown contains members of definite classes of substances.

Cells of *Zygosaccharomycetes* when transferred to pure water do not form spores. If, however, a carbohydrate or similar substance is present spores are formed, and this formation of spores occurs more rapidly in the presence of a simple monosaccharide than of a polysacchride or carbohydrate derivative, such as dulcitol. The addition of a trace of potassium phosphate and Witte's pepton accelerates the production of spores; ammonium salts, amino- and weak organic acids inhibit the reproductive process. The concentration of the medium may be varied within wide limits without entirely arresting the development of spores.

* Biochem. Journ., xi. (1917) pp. 71–7. See also Journ. Chem. Soc., i. (1917) p. 499.

† Journ. Biol. Chem., xxx. (1917) pp. 135–44. See also Journ. Chem. Soc., i. (1917) pp. 498–9.

‡ Journ. Coll. Sci. Imp. Univ. Tokyo, xxxix. (1916) 3, pp. 1–73. See also Journ. Chem. Soc., i. (1917) p. 499.

Thus highly concentrated solutions up to 25 p.c. of potassium nitrate do not inhibit spore-formation as much as an isotonic sodium chloride solution. The extreme limits of concentration applicable vary according to the previous training as regards food of the particular yeast employed, since yeasts, like bacteria and fungi, show adaptive capacity and may be gradually accustomed to unfamillar circumstances.

Most yeasts require the withdrawal of food before spore-formation can ensue. *Schizosaccharomycetes* is an exception to this rule, inasmuch as reproduction in this manner occurs in the unchanged medium, provided other conditions, such as temperature and degree of oxygenation, are favourable.

Contagious Agalaxy of Goats.*—E. Sergeant and G. Roig from their observations on the above disease in Algeria have arrived at the following conclusions :—"Contagious agalaxy of goats occurs in Algeria. We witnessed in 1908 an outbreak remarkable on account of its suddenness and its violence. In three months it killed off 124 out of 450 goats, attacking especially the young animals. In the natural disease mammary lesions are constant, articular lesions frequent, while ocular lesions are not observed. Thus animals not producing milk only show ocular symptoms. In the experimental disease the mammary and articular lesions are constant. Ocular lesions were observed in two out of thirteen cases. Inoculation of blood of infected animals did not transmit the disease and did not produce subsequent immunity. Inoculation of milk subcutaneously or intraperitonally produces the diseases with certainty in goats. Intraperitoneal inoculation does not infect the guinea-pig or the rat. The virus does not become attenuated by passage. Ingestion of infected milk does not produce the disease. In the outbreak studied a polymorphic organism belonging to the Preisz-Nocard group was constantly found in the milk, but not in the blood. The inoculation of cultures of the organism was not pathogenic. This organism is undoubtedly a concomitant parasite of the ultra-microscopic virus discovered by Celli and Dante de Blasi. It does not even seem to play the part filled by Carré's pyobacillus in "mal de Lure." It appears to be merely a secondary invader, following the infection by the specific virus."

Fæces and Bile of Cholera Cases and Carriers.†—B. C. Crowell and J. A. Johnston have examined the intestinal contents and the bile of 269 cases of cholera and cholera-carriers. In 212 cases of cholera the vibrio was found in the bile in 62·2 p.c., and in the bile only in 5·7 p.c. In thirty-two cholera-carriers, detected after death, the vibrio was found in the bile in 75 p.c., and in the bile alone in 43·7 p.c. In examining a large series of cholera cases the vibrio may not be recovered from the fæces in a certain number in which it is recovered from the bile. In cholera-carriers the vibrio was present in this series in the bile in 10 p.c. more cases than in cholera cases, and only in the bile in 38 p.c. more than in cholera cases. From this the

* Bull. Soc. Path. Exot., x. (1917) pp. 575–85.
† Philippine Journ. Sci., xii. (1917) pp. 85–103.

importance of routine examination of both bile and fæces becomes apparent. Five cases that were known to have been carriers before death were examined after death, and only in the one with the shortest period between detection and death (thirty-seven days) was the vibrio found. In that case the vibrio was isolated from the bile only. Thirty strains of non-agglutinable vibrios, isolated from the fæces and bile of cholera cases, cholera contacts and others, were studied. When first isolated these were non-agglutinable by high-titre cholera-immune serum. By growth on bile, eight of these strains acquired agglutinability. Five of these eight strains retained this property, and the other three lost it after cultivation for a period of two months. In six cases that were clinically and anatomically cholera, the cholera vibrio was not isolated from either the fæces or the bile. Such cases occur in a large series of cholera cases.

Mode of Invasion by the Meningococcus.*—C. Worster-Drought and A. M. Kennedy have investigated the above question and have arrived at the conclusion that the portal of entry of the meningococcus is via the blood stream. In the ordinary type of case the coccus is carried to the meninges by the blood within a few hours, without definitely infecting the blood itself. In some cases, however, blood infection occurs—e.g. in fulminating cases—prior to the envolvment of the meninges; the septicæmia then frequently overshadows the meningitis. In rare cases the organism may remain infecting the blood alone for a considerable time before finally reaching the meninges, or the patient may die of such septicæmia before meningitis can occur. In other instances the meningococcus infecting the blood may also invade structures other than the meninges—e.g. the cardiac valves. Catarrhal conditions predispose to meningococcal infection, but the meningococcus does not necessarily produce naso-pharyngeral catharrh.

Bacteriological Researches on Etiology of Sprue.†—H. Dold has made a comparative examination of normal stools and of those obtained from patients suffering from sprue. Yeasts were detected in 7·5 p.c. of the former and in 92·1 p.c. of the latter, while they were present to the extent of 16 p.c in cases of diarrhœa not associated with sprue. Either blastomycetes or oidia were present in the sprue stools, and were found to give acid and gas on glucose, lactose, maltose and mannite, which thus explain the acid reaction and gaseous character of sprue stools. Mice fed with an emulsion of these organisms mixed with bread or rice succumbed to a diarrhœa which presented the characters of sprue infection. The same experiment caused a transient diarrhœa in dogs. The results of serum agglutinations and complement fixation experiments were negative.

Carbohydrate Fermentation of Bacillus pestis.‡—H. W. Wade has carried out a series of carbohydrate experiments of various strains of plague collected from different sources. Comparison of the different

* Lancet, cxciii. (1917) pp. 711–4.
† Med. Record, xci. (1917) pp. 191–3.
‡ Philippine Journ. Sci., xi. (1917) pp. 159–82.

strains failed to demonstrate any distinction between Oriental and American strains, the organisms exhibiting a remarkable agreement, except with regard to the fermentation of glycerine. Two Manila strains fermented in this medium; the remainder of his Manila strains and the whole of his New Orleans strains gave no reaction. Generally speaking, dextrose, mannite and levulose were fermented regularly and fairly strongly. Maltose, arabinose, galactose and salcin were also fermented, but more irregularly, except under favourable conditions. Dextrin, lactose, saccharose, raffinose, adonite, dulcite, amygdalin, inosite, sorbite, mutrose and inulin were not changed in reaction.

The types of media and the different sugars used had various effects, some of them very definite and constant, on the amount of growth and on the morphology of the organism. On dextrose, mannite and levulose, in which media fermentation begins promptly, smears uniformly showed much degeneration and involution. When, however, acid production was delayed, degeneration and involution occur to a less extent. The cultures on sugars not acidified give well-stained organisms, though variation in morphology in different organisms is marked. Salicin usually produces long, often thready, and at times almost filamentous, organisms (*B. proteus* type) not at all recognizable as *B. pestis*. Dextrin and arabinous also show this tendency. Glycerin induces the formation of short, chunky, deeply-staining bacteria, often showing the typical bi-polar staining of *B. pestis* in exudates.

Bacillus paralacticus.* — *B. paralacticus* was isolated by F. Ducháček from lactobacilline. It produces in milk 0·6–0·7 p.c. lactic acid, while *B. bulgaricus* produces under the same conditions 2·3–2·5 p.c. The whole amount of the fermented sugar in the milk is converted into lactic acid. If the bacillus acts in the presence of the neutralized medium (in the presence of calcium carbonate), 50 p.c. of the sugar can be fermented in four months. Under the same conditions, *B. bulgaricus* can cause fermentation of the whole of the sugar within ten to fourteen days. The reason of this difference is that the coagulum produced in the fermentation is sufficiently acid to inhibit the action of the former species of bacillus. The best medium for the growth of *B. paralacticus* is peptonized malt extract containing a suitable sugar. A further distinction between *B. bulgaricus* and *B. paralacticus* is that the latter produces re-lactic acid, whereas the former produces an inactive acid. About 4·6 p.c. of the acid produced is in both cases acetic acid.

Colour-changes produced by Two Groups of Bacteria on Caseinogen and certain Amino-acids.† — Elfrida C. V. Cornish and R. S. Williams found that discoloured stilton cheese contains a large number of organisms belonging to many different groups. Similar micro-organisms are present in the milk from which the cheese is made, and also in the water-supplies of the farms from which the milk is obtained.

* Biochem. Zeitschr., lxxxii. (1917) pp. 31–47. See also Journ. Chem. Soc. i. (1917) pp. 612–3.

† Biochem. Journ., xi. (1917) pp. 180–7. See also Journ. Chem. Soc. i. (1917) p. 613.

The authors selected certain members of two of these groups, and have studied their action on caseinogen and amino-acids from the point of view of colour-production.

The two groups selected were the *Bacillus proteus* group and Gram-negative bacilli, which produced an alkaline reaction in solutions of various sugars, alcohols, etc. The results show that the members of the former group produced a well-marked amber colour in media containing tryptophane, whilst those of the latter group caused a yellow colour to appear in media containing tryptophane, and a definite brown colour in caseinogen solutions.

Invisible Microbe antagonistic to Dysenteric Bacilli.* — F. d'Herelle has isolated from the stools of persons convalescent from bacillary dysentry an invisible microbe endowed with properties antagonistic to Shiga's bacillus. More evidence seems to be required on this subject.

* Comptes Rendus, clxv. (1917) pp. 373–5.

MICROSCOPY.

A. Instruments, Accessories, etc.*

(1) Stands.

Spencer Mon-objective Binocular Microscope.† — The great feature of this instrument is that it is a binocular adapted for use with any standard microscope objective, from the lowest to the highest power oil-immersion objective. Both eyes are used at all times. The oculars are separated by simply turning a knurled ring on the right-hand tube, which is the most convenient position possible, involving a horizontal sliding movement capable of accommodating any pupillary distance from 50 to 75 mm. A knurled ring on the left tube serves as a correction collar to focus for the left eye independently of the right eye. A shutter is fitted inside, just below each eye-piece, operated by little handles at either side of the instrument. These shutters serve a double purpose— to be absolutely sure that one is seeing equally well with each eye; also, by closing of the left eye, to focus for the right eye by means of this side fine-adjustment. The tubes containing the eye-pieces are set at an angle of 4° from the perpendicular, which brings the point of convergence about 17 inches from the eye at the average pupillary distance. The eyes work normally without strain, and instantly blend the two images into one with the same ease as they do when viewing any ordinary object.

The instrument is made in two models, Nos. 1 and 2. No. 1 is fitted with a revolving mechanical stage, 120 mm. in diameter; and No. 2 has a plain rectangular stage, 110 by 112 mm.

(2) Eye-pieces and Objectives.

Notes on the Calculation of "Thin" Objectives.‡—In this paper, T. Smith arrives at formulæ for the calculation of the curves of thin achromatic objectives, when two aberration conditions have to be satisfied. A two-lens objective satisfying the conditions as a rule cannot be cemented, because the curvatures of the inner surfaces are unequal. He gives formulæ for the calculation of a triple objective satisfying the conditions, but with only two glass-air surfaces. Numerical examples are worked out, illustrating the application of the formulæ to the calcu-

* This subdivision contains (1) Stands; (2) Eye-pieces and Objectives; (3) Illuminating and other Apparatus; (4) Photomicrography; (5) Microscopical Optics and Manipulation; (6) Miscellaneous.

† Spencer Lens Co., Buffalo, N.Y., Catalogue, 1917.

‡ National Phys. Lab., Collected Researches, xiii. (1916) pp. 181–94; and Proc. Phys. Soc. Lond., xxvii. pt. 5 (1915).

lation of an astronomical object-glass, and the kinds of glass are determined with which a cemented doublet satisfies the conditions for this case.

Spencer Demonstration Ocular.*—This apparatus, as its name implies, is for demonstration purposes. It is a short tube, with an eye-piece at one end and a cap at the other. The cap is attached to the top of the body-tube of any compound microscope. The instructor looks through the eye-piece, directly over the tube, and at the same time the student looks through the eye-piece at the outer end of the demonstration ocular. A pointer, conveniently operated by a small knurled handle just below the eye-piece (over the microscope tube) is operated by the instructor, who is thus able to point to the exact detail to which he desires to call attention.

Choice of Glass for Cemented Objectives.†—It is well known that a telescope objective consisting of two compound lenses can be so constructed as to be simultaneously free from chromatic and spherical aberrations and from coma, provided proper forms are given to the components. When these are to be cemented together the three conditions can only be satisfied if a careful choice is made of the kinds of glass used. Tables have been published giving all the particulars necessary for the construction of such objectives when the corrections are required for an object at infinity. T. Smith's note, under the above title, deals with the changes in the kinds of glass to be employed when the objective is required to be free from these aberrations for objects at some finite distance.

(3) Illuminating and other Apparatus.

Spencer Delineascopes.‡—The Spencer Company have lately added Models 2 and 3 to their previous series of Delineascopes, or projection lanterns. No. 3 is a larger model than No. 2. The following notes refer to No. 2. This apparatus accomplishes both "opaque" and lantern-slide projection. The illuminated "opaque" area is 6 × 6 inches and will accommodate postcards, photographs, books, maps, small objects, etc. By an entirely new construction of base the entire operating end and sides of the apparatus are open and free from obstruction, thus facilitating ease of handling. The illumination is obtained from a Mazda bulb in its Mogul porcelain receptacle, and by an ingenious arrangement of interior mirrors the illumination of the opaque material and its screen picture is 20 to 25 p.c. more brilliant than is usually obtained with similar apparatus. The Mazda is gas-filled and of 400-volt power, and is attachable to any 110-volt incandescent lighting socket. Alternating or direct current may be used. The large projection objective is 4 inches in diameter and 16 inches equivalent focus. The method of supporting and focusing this large objective is entirely new, and is said to be free from the usual objections and to give results which are all that can be

* Spencer Lens Co., Buffalo, N.Y., Catalogue, 1917.
† National Phys. Lab., Collected Researches, xiii. (1916) pp. 197–208; and Proc. Phys. Soc. Lond., xxviii. pt. 4 (1916).
‡ Spencer Lens Co., Buffalo, N.Y., Catalogue, 1917.

desired. The change from the projection of opaque material to lantern slides, or *vice versa*, is accomplished simply by turning the handle at the side of the apparatus. The screen picture is 6 × 6 feet, while No. 3 gives an 8 × 8 feet picture.

Illumination for Distinguishing intra vitam Colour Reactions.* N. A. Cobb remarks that in order to distinguish with accuracy among

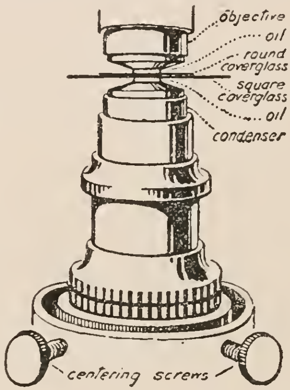

Fig. 1.

intra vitam colour reactions, it is necessary to be very particular about illumination. The best optical arrangement tried is the use of one apochromatic objective as a condenser for another apochromatic objective. The author has been using with success a 2 mm. as a condenser for a 2 mm. or 1·5 mm. apochromatic objective. This allows of fine colour distinctions being made.

The use of an ordinary apochromatic objective as a condenser neces-

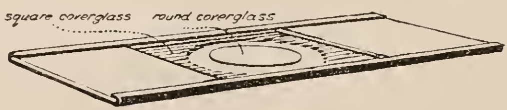

Fig. 2.

sitates the use of a special object-slide, consisting essentially of a carrier and two cover-glasses. The object is mounted between the cover-glasses (fig. 1). The substage of the microscope should have a centring arrangement and a rack-and-pinion or screw-focusing adjustment (fig. 2). A little experience with an apparatus of this sort, in which all known precautions are taken to remove colour from the optical system, leads one to distrust the ordinary Abbe substage condenser where fine distinctions are to be made between colours, especially if the colours are of similar character.

* Science, xlvi. (1917) p. 169 (2 figs.).

(4) Photomicrography.

Photographic Foucault-pendulum.*—E. F. Pigott has designed a photographic arrangement for supplementing the visual method of observation usually adopted in connexion with Foucault's well-known pendulum for demonstrating the diurnal rotation of the earth on its axis. He uses a large hollow heavy bob fitted internally with a small glow-lamp and a short focus lens. The gyrations of the light-spot are recorded on a sheet of bromide-paper placed below, and a permanent record free from personal equation is thus obtained.

Measuring the Focal Length of a Photographic Lens.†—The principal focus of a lens of focal length f is at a distance $f\mathrm{F}/f'$ from that of the combination of focal length F formed by placing in front of the first lens another of focal length f'. T. Smith points out that this suggests a simple method of finding the focal length of a photographic lens, which can be divided into two parts, each capable of producing a real image of a distant object. Let f and f' be the focal lengths of the two components, and F that of the complete lens. Set up the whole lens in the camera and focus a distant object sharply on the ground-glass. Now unscrew the front component of the lens from its mount without disturbing the rest of the lens, and measure the distance d through which the ground-glass has to be moved for the same object to be sharply focused by the back component used alone. Then $d = f\mathrm{F}/f'$. Next take the whole lens out of the camera and reverse it, so that what is usually the back component is now in front. Focus as before with the complete lens for a distant object, and measure the displacement of the ground-glass necessary to focus the same object when the component now in front is removed. Denote this by d', then $d' = f'\mathrm{F}/f$; and, therefore, $\mathrm{F}^2 = dd'$. This method avoids the difficulty of measuring exactly a transverse magnification, and also is not subject to errors arising from want of parallelism of object and image, from distortion and other oblique aberrations. The author gives several developments of his method.

(5) Microscopical Optics and Manipulation.

Tracing Rays through an Optical System.‡—The most troublesome calculations which have to be made in computing an optical system are those relating to rays not lying in an axial plane. The methods hitherto used are trigonometrical, and the formulæ most extensively employed are those of Von Seidel; but T. Smith points out that, although these equations have the advantage of being in a form suitable for logarithmic computation, the process is very tedious—nine equations have to be solved for each surface—and the method does not readily indicate what modifications should be made in the system when the ray does not emerge as is desired. An algebraic method is preferable, pre-

* Journ. and Proc. New South Wales, l. (1916) pp. 262–9 (1 pl.).
† National Phys. Lab., Collected Researches, xiii. (1916) pp. 167–8; and Proc. Phys. Soc. Lond., xxvii. pt. 2 (1915).
‡ National Phys. Lab., Collected Researches, xiii. (1916) pp. 171–7; and Proc. Phys. Soc. Lond., xxvii. pt. 5 (1915).

cisely because it is free from this objection, and the fact that it is not as well suited for logarithmic work is of no importance where a calculating machine is employed. The author proceeds to develop his algebraical equations, which have the advantage of checking one another. Moreover, if the performance of the optical system should prove unsatisfactory, it is probable that a comparison of certain corresponding quantities would suggest what modifications are necessary to amend the system in the direction desired.

(6) Miscellaneous.

Ultra-microscopic Investigation of the Tanning Process in Jellies.*—W. Moeller gives a further description of the conditions of formation of laminated structures in the action of aqueous solutions on jellies. The formation of an insoluble salt by the interaction of an electrolyte in the aqueous solution and a second electrolyte in the jelly is not an essential condition in the production of such structures. It has been found that an aqueous solution of silver nitrate when left in contact with a gelatin jelly containing no added electrolyte gives rise to the formation of alternating layers. The laminated structure would seem to be produced when any ionizable salt diffuses into a jelly. The same heterogeneous structure results when gelatin jellies are subjected to the action of tanning solutions. It is considered that the ultra-microscopic observations cannot be interpreted satisfactorily in terms of the hypotheses previously set forward, and that the rhythmic lamination can only be accounted for in terms of the structure of the jelly. The author's view that gelatin consists of a fibrillated substance (α-gelatin), the spaces between the fibrils being filled by a structureless substance (β-gelatin), is made the basis of an explanation of the rhythmic effects which are the result of the diffusion processes which occur when jellies are brought into contact with solutions of salts.

B. Technique.†

(1) Collecting Objects, including Culture Processes.

Medium for obtaining Anaerobes in Exudates.‡—E. S. Harde finds that the following medium gives good results :—20 p.c. gelatin to which is added 2 c.cm. of beef or veal. The tubes are then incubated at 37·5. It is important to sow the tubes with much exudate. Pure cultures are then made in the usual way.

Method for the Rapid Determination of Bacillus diphtheriæ.§—S. Costa, J. Troisier, and J. Dauvergne use the following medium :—Horse

* Kolloid Zeitschr., xx. (1917) pp. 257–70. See also Journ. Chem. Soc., ii. (1917) p. 454.

† This subdivision contains (1) Collecting Objects, including Culture Processes; (2) Preparing Objects; (3) Cutting, including Embedding and Microtomes (4) Staining and Injecting; (5) Mounting, including slides, preservative fluids, etc. (6) Miscellaneous.

‡ C.R. Soc. Biol. Paris, lxxx. (1917) p. 661.

§ C.R. Soc. Biol. Paris, lxxx. (1917) pp. 678–80.

serum, 100 c.cm.; glucose, 30 p.c., 10 c.cm.; tincture of litmus, 30 drops; sulphuric acid, 1 p.c., 3 c.cm. This medium is distributed into Petri capsules and then coagulated in an autoclave for seventy-five to eighty minutes. On removal from the autoclave the condensation is poured off, and if necessary the capsules are dried in a stove. In this medium the diphtheria colonies are red, the diphtheroids blue, while the contaminations do not grow at all or very scantily.

Amygdalin as Nutriment for Aspergillus niger.*—H. J. Watermen states that earlier observations have shown that amygdalin is resolved into dextrose, benzaldehyde and hydrogen cyanide by the extract from the cells of *Aspergillus niger*. This does not occur with the living cells, and in these circumstances the amygdalin is absorbed and assimilated by the mould which multiplies in the amygdalin solution. The experiments now described show that the organism will not develop if any considerable proportion of the amygdalin is already hydrolysed. The retardation is mainly due to the benzaldehyde, the action of which is possibly due to its ready solubility in fats, and on the other hand to its rapid oxidation to benzoic acid. The behaviour of amygdalin and its products of hydrolysis towards the cells of *Aspergillus niger* affords an indication of a general method for the introduction of narcotic substances into living organisms.

Spirochæta forans.†—H. Reiter has isolated an organism, which he calls *Spirochæta forans*, from the venous blood of a patient suffering from pains in the joints, splenic enlargement, conjunctivitis, cystitis and fever of a week's duration. The organism grew freely in ascitic fluid broth and stained readily with alcoholic fuchsin, methylen-blue and Giemsa. The number of coils displayed by the parasite vary with the age of the cultures, the younger forms having the appearance of vibrios. The fully grown *S. forans* is similar in appearance to *Treponema pallidum*, but is stouter and stains with less difficulty.

Growth of Anaerobic Bacilli in Fluid Media under apparently Aerobic Conditions.‡—S. R. Douglas and others record experiments which demonstrate that anaerobic bacilli will grow both more rapidly and also from a smaller implantation when, in addition to the usual anaerobic conditions, some porous substance, such as potato or asbestos wool, is added to the culture medium.

Action of Spinal Fluid in Stimulating the Growth of the Meningococcus.§—C. Shearer records experiments the results of which show that there is present in normal spinal fluid some substance that greatly increases the rate of growth of the meningococcus on an artificial culture medium. They clearly demonstrate that this power, in the case of human spinal fluid, is relatively greater than that shown by blood or

* Proc. K. Akad. Wetensch. Amsterdam, xix. (1917) pp. 922–7. See also Journ. Chem. Soc., i. (1917) p. 502.

† Centralbl. f. Bakt., 1te Abt. Orig., xxxix. (1917) pp. 176–80.

‡ Lancet, Oct. 6, 1917, pp. 530–2.

§ Lancet (1917) ii. pp. 714–5.

nasal secretion; that, volume for volume, spinal fluid brings about a much thicker growth of the meningococcus than do the same volumes of blood or nasal secretion.

Bertetti, E., & G. Finzi—**Sulle proprietà dei sieri di animali iperimmunizati contra la morva e sulla scelta degli animali per la preparatione di sieri ricchi in anticorpi antimorphosi.**

[Deals with the possibility of obtaining anti-glanders sera from various animals.] *Atti d. R. Accad. d. Lincei*, xxvi. (1917) pp. 131–5.

(2) Preparing Objects.

Investigating Cytoplasmic Inclusions of Germ-cells.* — J. B. Gatenby fixed most of his material, germ-cells of Lepidoptera, in strong Flemming without acetic acid, or in Champy's fluid. Sections were stained on the slide with iron-hæmatoxylin, Ehrlich's hæmatoxylin and Orange G, methyl-blue eosin, Mayer's acid hæmalum, pyronin and methyl-green, Breinl's process, or the carmin stains. Alizarin and crystal-violet and iron-hæmatoxylin were used especially for mitochondria.

Regaud's formol bichromate gave useful results with smears of testes. These were first fixed in osmic vapour, and then soaked for a short time in Regaud; afterwards they were placed in 90 p.c. alcohol for several hours. They were then stained in iron-hæmatoxylin. As a rule in such preparations the mitochondria alone were stained. Afterwards Bensley's permanganate of potash and fuchsin stain was used, but no stain was found to approach iron-hæmatoxylin for certainty and usefulness.

Investigating Pharyngeal Gland-cells of Earthworms.† — J. Stephenson employed Zenker's fluid and sublimate-acetic for fixing the embryos and smaller worms, including the adults of *Helodrilus parvus*; some specimens of *Pheretima* were similarly treated. Narcotization with chloreton and fixation by 10 p.c. formalin were employed for most of the adult specimens of *Pheretima* and *Helodrilus caliginosus*. For staining, the most generally useful method is some degree of overstaining with Delafield's hæmatoxylin, differentiation with acid-alcohol, and counter-staining with alcohol-eosion. Dobell's modification of Heidenhain's iron-hæmatoxylin method also gave excellent results. In addition, Heidenhain's original chrom-hæmatoxylin method was used. This gave unsurpassed differentiation of epithelial cells (skin, pharynx, œsophagus), but was useless for the cells of the pharyngeal mass. Van Gieson's stain and borax-carmin, followed by picro-indigo carmin, were useful in differentiating the connective-tissue, and in distinguishing it from the muscular fibre.

Maclicquer, J.—**Instructions for the Collection, Preparation, and Conservation of Marine Animals.**

[The instructions are copious and careful, and the monograph is illustrated with numerous engravings.]

Publicaciones de la Junta de Ciencies Naturalo di Barcelona, i. (1917), 55 pp. (3 pls.).

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* Quart. Journ. Micr. Sci., lxii. (1917) pp. 412–3.

† Quart. Journ. Micr. Sci., lxii. (1917) pp. 260–1.

(4) Staining and Injecting.

Solution for Staining Protozoa and Blood-corpuscles.* — T. Watabiki makes the solutions in the following way:—Solution 1: methyl-blue (sic) 1; absolute alcohol, 10; carbonate of soda, 1; distilled water, 90. This mixture is incubated for two days at 37° C. Solution 2 consists of yellow water-soluble eosin, 1; distilled water, 200. The two solutions are mixed, and then incubated for twenty-four hours at 37° C. The dry powder, 0·3–0·5 grm., is called methylen-azureosine. The final solution consists of methylen-azureosine, 0·5; methyl-alcohol, 150; neutral glycerin, 150. Staining of preparations is done in the usual way. Leucocytes and bacteria stain in three to five minutes; Protozoa take from five to thirty minutes.

Demonstrating the Presence of Spirochætes in the Urine in Cases of Trench Fever.†—A. T. Nankivell and C. E. Sundell adopted the following procedure:—Ten c.cm. of urine are centrifuged at high speed for fifteen minutes. The supernatant fluid is pipetted off and 5 c.cm. of distilled water added. The fluid is again centrifuged for fifteen minutes and the supernatant fluid pipetted off. Films are then made by placing three loopfuls on a slide. The preparation is then dried in an incubator. The majority of the specimens were stained by a modified Fantana silver method. The film is washed for two minutes with a solution of 8 p.c. formalin and 1 p.c. glacial acetic acid. The film is then washed in absolute alcohol, and when nearly dry is washed with distilled water and then flooded with a hot 5 p.c. solution of tannic acid, containing 1 p.c. of carbolic acid. After allowing the mordant to act for two minutes the film is washed in distilled water. A 2 p.c. silver nitrate solution, to which a trace of ammonium hydrate is added, is pipetted over the film until a dark brown colour is obtained. The slide is then washed with distilled water and afterwards dried in a current of cold air. The film should be mounted in Canada balsam. The spirochætes appear jet black against a grey or brown background. With dark ground illumination they are white. With Giemsa's stain they stain pale red with a tinge of blue, but with dark ground illumination they are yellow. An alternative staining to Fontana or Giemsa is carbol-fuchsin. The spirochætes stain pink by this method.

(6) Miscellaneous.

Micro-chemical Reaction for Calcite.‡—St. J. Thugutt states that calcite when intermixed with zeolites can be recognized by the following reactions: The powdered mineral (grains about 0·1 mm. diam.) is heated on platinum foil over a Tecla burner for fifteen seconds and then treated with N/10 cobalt nitrate. The calcite becomes coated with a thin skin of blue basic cobalt salt, whilst the zeolites are unaffected. Removing

* Kitasato Archives of Exper. Med., i. (1917) pp. 153–6.
† Lancet (1917) ii. pp. 672–4.
‡ Journ. Chem. Soc., ii. (1917) p. 508.

excess of the cobalt solution and adding N/10 silver nitrate, the bases of the zeolites are soon replaced by silver (diluted with potassium chromate), whilst the basic cobalt salt becomes black, owing to the formation of $Co(OH)_3$, and this quickly reduces the silver salt, producing a deposit of metallic silver on the calcite.

Metallography, etc.

Ancient Peruvian Bronzes.*—A detailed description is given by C. H. Mathewson of the results of a metallographic examination of a number of ancient bronze articles collected at Machu Picchu, in Peru, by the National Geographic Society—Yale University Peruvian Expedition of 1912. In the first part of the paper the author points out the possibilities and limitations of metallographic investigations in regard to the determination of the past history of such specimens. The investigation has revealed a considerable amount of knowledge concerning the methods used by the Incas in producing the articles—e.g. conditions of casting, mechanical working, and annealing—but it is not possible by metallographic methods alone to establish their age. Chemical analyses of the articles studied are given. They were irregular in composition, ranging from 3 to 13 p.c. tin, but they were remarkably pure. Their purity, together with the fact that one article consisted of practically pure tin, leads to the conclusion that the Incas were acquainted with tin in an elementary state, and that the bronzes were made by alloying purified copper and tin and not by smelting the mixed ores. All contained a certain amount of sulphur, some much less than others, recognizable under the microscope as cuprous sulphide. There is evidence that the Incas had attained considerable skill in the art of casting, but they were not acquainted with the use of addition agents for deoxidizing purposes, as the castings are frequently unsound and consequently lacking in hardness and strength. Perforations were obtained by casting rather than by mechanical means, thus avoiding the difficulty of obtaining tools to pierce such a tough material as bronze. No evidence was obtained that the articles had undergone any special heat treatment. The structures were generally non-uniform and of small grain size, such as is characteristic of bronze worked at low temperatures. The author discusses in general the relation between the rate of grain-growth in bronze and temperature of annealing, time of annealing, and extent of cold-work previously received, in connexion with its bearing upon the interpretation of the structures of the ancient bronzes. Numerous photomicrographs of etched sections taken from the articles investigated are given, together with diagrams illustrating the articles, and the positions to which the etched sections correspond.

Methods and Results of Etching.†—A general account of the methods of metallographic etching and etching phenomena is given by

* Amer. Journ. Sci., xl. (1915) pp. 525–98 (46 figs.).
† Stahl und Eisen, xxxv. (1915) pp. 1073–8, 1129–35 (21 figs).

J. Czochralski. Three types of etching are distinguished and discussed: (1) crystal-boundary etching, (2) crystal-field etching, (3) crystal-figure etching, each type being illustrated by photomicrographs. The effect of cold-working upon structure is considered. The last part of the paper is devoted to a discussion of the methods of polishing specimens, and the application of different etching reagents, including heat-tinting and electrolytic methods of etching. A table is included which shows the reagents to be used to bring about the three types of etching for most of the common metals and their alloys.

Alloys of Iron and Boron.*—The constitution of alloys of iron and boron containing up to 11 p.c. boron have been studied by N. Tschischewsky and A. Herdt, by taking cooling curves and by microscopic examination of a series of alloys, which were prepared by melting together pure Swedish iron and requisite amounts of ferro-boron containing 23·7 p.c. boron. For the examination of structures the alloys were slowly cooled, and etched with sodium-picrate. The polished surfaces of eutectic alloys present a more "pearly" appearance than the corresponding steels, so that the eutectic can be termed "boron pearlite." This eutectic becomes perceptible at 0·08 p.c. boron, and appears as thin pearlitic lines separated by masses of ferrite. As the boron-content increases, the pearlitic veins increase in width, till at 3·1 p.c. boron the eutectic composition is reached. With further increase in boron-content crystals of boride (Fe_2B) appear. The boride assumes well-defined prismatic forms, and is coloured, when etched, with sodium-picrate, and may be termed "boron cementite." The alloy containing 8·85 p.c. boron consists entirely of long prismatic crystals of the boride. Polished sections of alloys exceeding 9 p.c. boron were very difficult to prepare owing to brittleness. The equilibrium diagram prepared from the results shows the formation of a eutectic on solidification at 3·1 p.c. boron and a temperature of 1135° C. All alloys show a change in the solid at about 760° C., corresponding to the transformation of gamma- to alpha-iron.

Cementation of Iron by Hydrocarbon Gases.†—F. C. Langenberg describes experiments with a specially designed electric furnace in which specimens of pure iron were subjected to the action of (1) illuminating gas, (2) acetylene, under varying conditions with regard to temperature, time, rate of flow and pressure. The furnace could be evacuated before heating up, thus no oxidation of the specimens occurred, and the amount of carbon absorbed was determined by noting the increase of weight and the depth of the cemented case by the microscopic examination of transverse sections. Under certain conditions it is shown that the gases actually exert a decarburizing action. This occurs with slow rates of flow, and is due to deposition of carbon from the gas before reaching the temperature of the hot portion of the furnace. A specimen of white iron was reduced in carbon-content from 2·5 to 6·5 p.c. by this action. The structure of the decarburized white

* Rev. Soc. Russ. Métallurgie, i. (1915) pp. 535–46, through Rev. Métallurgie xiv. (1917) Extraits, pp. 21–7 (7 figs.).
† Journ. Iron and Steel Inst., xcv. (1917, 1) pp. 129–53 (12 figs.).

iron and of other decarburized specimens showed peculiar streamers of ferrite running from the edge to the centre. By inserting a length of solid carbon in the hot part of the furnace this decarburizing action was avoided. The degree of carburization was found to increase with increase of rate of flow of gas, temperature and pressure. A sudden increase in the amount of carbon absorbed occurred between 890° and 900°, which is considered to correspond with the beta-gamma allotropic change in pure iron. There is a limiting temperature between 710° and 810° below which carburization will not occur. The effect of pressure holds up to a critical value (which varies with the temperature) beyond which increase of pressure has very little effect. The character of the cemented cases does not conform to the prevailing view that hydrocarbons give cases high in cementite. With atmospheric pressure the carbon-content of the case did not exceed the eutectoid ratio under any conditions, and hypereutectoid layers in the case were only obtained by the use of high pressures. Several photomicrographs are given illustrating the character and depth of cemented cases produced under different conditions.

Influence of Surface-tension on the Properties of Metals.*—A further acconnt is given by F. C. Thompson of the theory of the existence of surface-tension forces operating in metals at the junctions between the crystals and the inter-crystalline films of amorphous modification. The author also replies to criticism of the views previously put forward. Analogies are drawn from the phenomena noted with metallic crystals in the presence of the liquid metal. The rounding of the angles of dendrites of metals, such as lead and tin, withdrawn from the residual liquor during solidification, is attributed to similar surface-tension forces acting between the liquid amorphous conditiou and the solid crystalline condition. Explanations are given, based on the theory, of the structural re-arrangements which follow the annealing of plastically deformed ferrite and of other phenomena. Surface-tension forces are at work in the granulation of pearlite produced by long annealing of high carbon steels at temperatures of about 650° C., as an examination of structures intermediate between the lamellar and spheroidal forms shows that the carbide plates break up into drops before coalescence occurs.

* Journ. Iron and Steel Inst., xcv. (1917, 1) pp. 155-74 (7 figs.).

PROCEEDINGS OF THE SOCIETY.

AN ORDINARY MEETING

OF THE SOCIETY WAS HELD AT 20 HANOVER SQUARE, W., ON WEDNESDAY, OCTOBER 17TH, 1917, MR. E. HERON-ALLEN, F.L.S., F.Z.S., ETC., PRESIDENT, IN THE CHAIR.

The Minutes of the last Meeting, having been circulated, were taken as read, approved, and signed by the President.

The President opened the Session in a short speech, in which he commented upon the war activities of the various scientific societies, and pointed out how, under the hegemony of the Royal Society's "Joint Board," loss of energy due to overlapping of interests would in future be avoided.

The President announced that Mr. Joseph Smith and Mr. Gregory Rawlings had been proposed as Fellows, and the ballot for them would be taken at the next Meeting.

He also announced the receipt by the Society of the following Donations to the Library :—

	From
Gage, Simon H., "The Microscope," 12th edition	*The Publishers.*
Wood, Casey A., "The Fundus Oculi of Birds"	*The Author.*
Gibbs, L. S., "Phytogeography and Flora of the Arfak Mountains"	*The Publishers.*

Equally important donations comprised an Old Microscope, presented by Mr. Radley, which (pending the report of the Curators) he would merely state was a specimen of the Ellis Aquatic type; and some extremely interesting Microscopical Apparatus Mr. Ingpen had presented, through Mr. Parsons, which he would ask Mr. Parsons to describe.

The Society voted its thanks to the various donors.

Mr. Parsons said that the items that Mr. Ingpen had presented to the Society were (1) an immersion paraboloid illuminator, devised by Dr. James Edmunds; (2) a sub-stage condensor for oblique light, by Powell and Lealand; (3) an Abbe diffraction plate, diaphragms, and carrier, with arrangement for rotating the diaphragms, for demonstrating the effects of diffraction on the formation of microscopical images; and (4) the identical Zeiss "*aa*" objective used by Professor Abbe in demonstrating his diffraction theory. Dr. Edmunds exhibited his immersion paraboloid at a meeting of the Quekett Microscopical Club on October 6th, 1877. The top of the paraboloid was cut off by an exactly calculated distance below its focus, the distance varying, in the four lenses constituting the set, the plane top being made optically continuous with the slide by means of a fluid of high refractive index, such as glycerin, castor oil, oil of cloves, etc. No. 1 lens was calculated for use with a slide of ordinary thickness, say $\frac{1}{16}$th of an inch. No. 2 lens was calculated for use with a slide not exceeding $\frac{1}{100}$th of an inch in thickness. The thickness of slide for which the others were proportioned is not stated. The example presented to the Society was presumably a No. 1; it belonged to Dr. Carpenter, and was probably made by Powell and Lealand. Dr. Edmunds claimed to have obtained highly satisfactory results, but Dr. Dallinger, in his edition of Carpenter, criticized it severely. He (the speaker) had not yet succeeded in finding a description of the sub-stage condensor for oblique illumination; and although Mr. Ingpen assured him it was made by Powell and Lealand, Mr. Powell did not recognize this particular accessory. It was probably of the same date as the paraboloid.

Coming to the accessories illustrating the Abbe diffraction theory, Mr. Parsons referred to a paper by J. W. Stephenson, entitled "Observations on Professor Abbe's Experiments illustrating his Theory of Microscopic Vision," in the Transactions of the Society in the "Monthly Microscopical Journal" for February, 1877, and a translation by Dr. H. S. Fripp of Professor Abbe's "Contribution to the Theory of the Microscope and the Nature of Microscopic Vision," which appeared in the Proceedings of the Bristol Naturalists' Society, n.s., vol. i., pt. 2. (Both papers are in the Society's Library.)

The President proposed a vote of thanks to Mr. Parsons for having influenced this gift, and for having brought it forward in this way. The occasion gave him an opportunity of proposing another vote of thanks to Mr. Parsons. It would be known to Fellows that the Assistant-Secretary was called up some months ago, with the suddenness with which such things happened, and the Society was, consequently, placed in considerable difficulty. Mr. Parsons, who was formerly Assistant-Secretary for many years, and was the steerer of their ship through a good many troubled waters, was good enough to come back at once and assist the lady who took the reins of government into her hands, but who, unfortunately, had been prevented from carrying on those duties by the illness of her husband. Although the Society was fortunate in having now secured the services of one whom he was sure would prove an extremely efficient Assistant-Secretary, they must not lose sight of the fact that they owed a very great debt of gratitude to Mr. Parsons. The Council, at their meeting that evening, decided that this vote of thanks should be proposed from the chair at this meeting. They also voted an inadequate—but in war times all good impulses must, *ex facto*, be inadequate—honorarium to Mr. Parsons, which would reach him in due course. For the moment he asked the meeting to pass this vote of thanks to Mr. Parsons for the excellent services he had performed for the old Society at a time when it most required them.

Carried by acclamation.

Mr. Scourfield said he had brought that evening some specimens of the ordinary or parthenogenetic female, the ephippial female, and the male of the Entomostracon *Simocephalus exspinosus*. In the ephippal female there was a modification of the back of the shell, known as the ephippium, intended for the reception of the resting egg. The ephippium when thrown off could be dried up or frozen, but its contained egg would hatch out when the conditions became favourable again. Males and ephippial females occurred only at certain seasons of the year, and he had records of the occurrence of these forms in the Epping Forest district from which it appeared that they were to be found mainly in June and October, or round about those months. It was, however, a very common occurrence amongst the Cladocera, the group to which the specimens of course belonged, that the sexually mature individuals should appear only at certain seasons of the year. The male, it might be mentioned, did not differ very much from the young female, and might therefore be very easily overlooked.

Mr. Earland then exhibited lantern-slides illustrating some of the species recorded by Mr. Henry Sidebottom in his "Report on the Recent Foraminifera Dredged off the East Coast of Australia, H.M.S. 'Dart,' Station 19 (14th of May, 1895), lat. 29° 22′ S., long. 153° 57′ E., 465 fathoms."

The President said he was sure it would be the wish of Fellows to record a hearty vote of thanks to Mr. Sidebottom for his communication, which, in due course, would appear in the Society's Journal, and also thanks to Mr. Earland for showing and explaining the slides.

Carried by acclamation.

Mr. F. Martin Duncan then communicated a paper, "On Mounting and Preserving Marine Biological Specimens," but owing to the lateness of the hour it was agreed to ask the author to exhibit the slides illustrating the paper at the next Meeting of the Society.

The President proposed a hearty vote of thanks to Mr. Martin Duncan for the paper, and also that the best thanks of the Society be given to Mr. Angus for the loan of the microscopes used for the exhibitions of the evening, both of which were carried unanimously.

The next Meeting was announced for November 21, and the next Meeting of the Biological Section for Wednesday, November 7.

The following Instruments, etc., were exhibited:—

The Society:—An Old Microscope, by T. Harris and Son, 52 Great Russell Street, Bloomsbury, presented by Mr. Radley; and the following Apparatus, presented by Mr. J. E. Ingpen: An Immersion Paraboloid, devised by Dr. Jas. Edmunds; an Abbe Diffraction Plate, Diaphragms and Carrier; the Zeiss "*aa*" Objective used by Professor Abbe in demonstrating his Diffraction Theory; a Powell and Lealand Sub-stage Condenser for Oblique Illumination.

Mr. D. J. Scourfield:—*Simocephalus exspinosus*. (1) Ordinary parthenogenetic female, (2) ephippial female, (3) male.

Mr. A. Earland:—A series of seventy-one Lantern-slides of Foraminifera, shown on the screen in illustration of his exposition of Mr. H. Sidebottom's paper.

Mr. F. Martin Duncan:—The following specimens were exhibited under microscopes, in illustration of his paper, "On Mounting and Preserving Marine Biological Specimens":—

Pachymatisma johnstonia. Killed and preserved in alcohol. Stained with borax-carmine. Mounted in Canada balsam.

Medusa, *Cladonema radiatum*. Narcotized with 1 p.c. cocaine-hydrochloride. Preservative, 4 p.c. formaldehyde. Mounted in 3 p.c. formaldehyde.

Hydractina echinata. Narcotized with menthol. Killed and preserved in 70 p.c. alcohol. Stained picro-carmine. Mounted in Canada balsam.

Medusa, *Obelia geniculata*. Killed and preserved in 4 p.c. formaldehyde. Mounted in 3 p.c. formaldehyde.

Sertularia pumila. Narcotic alcohol. Killed and preserved in 70 p.c. alcohol. Stained carmine. Mounted in Canada balsam.

Expanded Polyps of *Corallium rubrum*. Narcotized with 1 p.c. cocaine-hydrochloride. Preserved in 70 p.c. alcohol.

Larval stages, *Balanus balanoides*. From Tow-net collection. Killed and preserved in 10 p.c. formaldehyde. Mounted in 3 p.c. formaldehyde.

Anthura gracilis. Killed and preserved in formal-alcohol. Stained picro-carmine. Cleared in turpineol. Mounted in Canada balsam.

Chelura terebans. Same method as in *A. gracilis*.

Podocerus falcatus. " " "

Embryos of Goby. Preserved in 10 p.c. formaldehyde. Mounted in 4 p.c. formaldehyde.

AN ORDINARY MEETING

OF THE SOCIETY WAS HELD AT NO. 20 HANOVER SQUARE, W., ON WEDNESDAY, NOVEMBER 21ST, 1917, MR. J. E. BARNARD, VICE-PRESIDENT, IN THE CHAIR.

The Minutes, having been duly circulated, were taken as read, confirmed, and signed by the Chairman.

The Chairman invited Fellows to nominate candidates for election to the Council by sending names, each supported by three sponsors, to the Secretary as soon as possible.

Mr. Scourfield exhibited the protonema of the so-called "luminous moss," *Schistostega*. It was not a common moss, although it had been recorded from several parts of England, occurring in such situations as disused mine adits, entrances to caves, and even in rabbit-burrows. He was shown this moss for the first time this year by Mr. G. T. Harris, of Sidmouth, in rabbit-burrows on Dartmoor. When seen, it was a most striking object. The moss, or rather its protonema, appeared to glow with a metallic golden-green light, producing an effect similar to that obtained from some tropical butterflies, or from certain humming-birds. This was not due to phosphorescence, but to reflection of light by certain special cells, the reflected light being no doubt modified by the presence of chlorophyll. A specimen, growing on a stone, was under one of the microscopes, illuminated by a vertical illuminator, and showed, to some extent, how the light was reflected. In ordinary mosses the protonema was composed of a series of threads, resembling a filamentous alga; but in *Schistostega* the threads at certain points developed into special cells, with eight to sixteen chlorophyll grains arranged as a rule at the bottom of each cell. The cells were nearly spherical, but seen edge-on produced the paraboloid effect shown in the drawing on the black-board of a figure from Strasburger's "Text-Book of Botany." It had been suggested that incident light, after entering the cell, was reflected from the sloping sides, across the cell, and out again.

The Chairman remarked that mere reflection was hardly sufficient to account for the emission of light which had a dominant wave-length, so that green coloration was produced.

Mr. Scourfield believed that the greenish colour was due to the chlorophyll.

The Chairman, continuing, said in this case it was probably due to a change in the wave-length of the light entering the moss, due to absorption of part of the light, rather than to simple reflection, and was somewhat parallel to the emission of light by luminous bacteria. There the light was of one wave-length, and it constituted a wonderful example of the economy of Nature; there was no loss at all, no wave-length except that definite one which the organism had use for. There was no example in commerce or in the Arts comparable in which the production of light of one wave-length had been achieved without accompanying wave-lengths which were not particularly wanted.

Mr. Scourfield suggested spectroscopic examination of the reflected light, with a view to the elucidation of the problem; and the **Chairman** agreed that such examination would settle whether reflection was a prime factor in the phenomenon.

Mr. Scourfield was cordially thanked for his exhibit.

Mr. Wilson, who exhibited six species of *Micrasterias*, said the genus was a small one, and included some eighteen British species and a few varieties. Three species were found by the late James Murray only in the Scottish lakes; and while six species were very rare, six other species might be classed rare, and the remainder were confined to certain localities. They were found in the bogs and lakes among the hills of the older Palæozoic rocks, chiefly in the Highlands of Scotland, the Cumberland Hills, and North Wales. Of the more common species, *M. rotata* was abundant in some of the Epping Forest pools, and *M. denticulata* so plentiful on Sheen Common as almost to tinge the water green, as in the bottle exhibited.

Mr. Wilson was cordially thanked for his exhibit.

Mr. Paulson presented a Report on Biological Work at Ruhleben (with slides), compiled from letters written to him by Dr. A. E. Lechmere, Lecturer in Mycology, University of Bristol, and Mr. Michael S. Pease, B.A. Cantab., both of whom are at present interned in the Camp.

On the motion of the Chairman a vote of thanks for his report was accorded to Mr. Paulson.

Mr. Martin Duncan exhibited a series of lantern slides illustrating the paper he had communicated at the October meeting of the Society, and tracing the life-history of *Orpulina.*

Messrs. E. Heron-Allen and **Arthur Earland** read a paper on variation in the arenaceous rhizopod *Thurammina papillata* Brady, based on a study of many thousands of specimens dredged by the Scottish Fisheries' Cruiser "Goldseeker" in the North Sea and North Atlantic. They regarded all hitherto recorded species of *Thurammina* and *Thuramminopsis* as varieties of the original type *Thurammina papillata* Brady, and as having no biological significance. For taxonomic reasons most of the specific names were retained with varietal values, and certain new varietal names were proposed for forms not previously separated or recorded. The life-history of the genus was for the first time worked out.

The paper was illustrated by a number of lantern slides prepared from direct photographs, and will appear *in extenso* in the pages of the Journal.

A vote of thanks to the authors was carried by acclamation.

Messrs. Joseph Smith and Francis Ian G. Rawlins were declared duly elected, and the nomination on behalf of Mr. Fenwick was duly read.

It was announced that the next ordinary meeting would be held on December 19th, when Professor Bateson would read a paper on "Cytology and Genetics"; and that of the Biological Section on December 5th.

The following Objects, etc., were exhibited :—

Mr. D. J. Scourfield :—Living Protonema of the so-called "Luminous Moss," *Schistostega osmundacea*, showing the special cells which reflect the light : (1) growing on a stone (under $\frac{2}{3}$-in. objective with vertical illuminator), (2) as a transparent object (under $\frac{1}{6}$-in. objective).

Mr. J. Wilson :—*Micrasterias oscitans*, *M. truncata*, *M. sol* (Ehr.), *M. apiculata* var. *brachyptera*, *M. rotata*, and *M. denticulata*.

Mr. R. Paulson :—Lantern slides in illustration of the Report of Dr. A. E. Lechmere on Biological Work at Ruhleben.

Mr. F. Martin Duncan :—Lantern-slides in illustration of his paper "On Mounting and Preserving Marine Biological Specimens," read at the last Meeting.

Messrs. Heron-Allen and A. Earland :—The following slides under Microscopes : *Thurammina papillata* Brady, the "Orbuline *Lituola*" of Carpenter, type; *T. papillata* Brady, new variety, *castanea* Heron-Allen and Earland, Chitinous and Arenaceous forms; *T. papillata* Brady, new variety, *haeusleri* Heron-Allen and Earland : *T. papillata* Brady, variety *albicans* Brady : specimen laid open, showing formation of young individuals in the parent chamber.

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