TRANSACTIONS

OF THE

Perthshire Society of Natural Science.

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OF THE

PERTHSHIRE SOCIETY OF NATURAL SCIENCE

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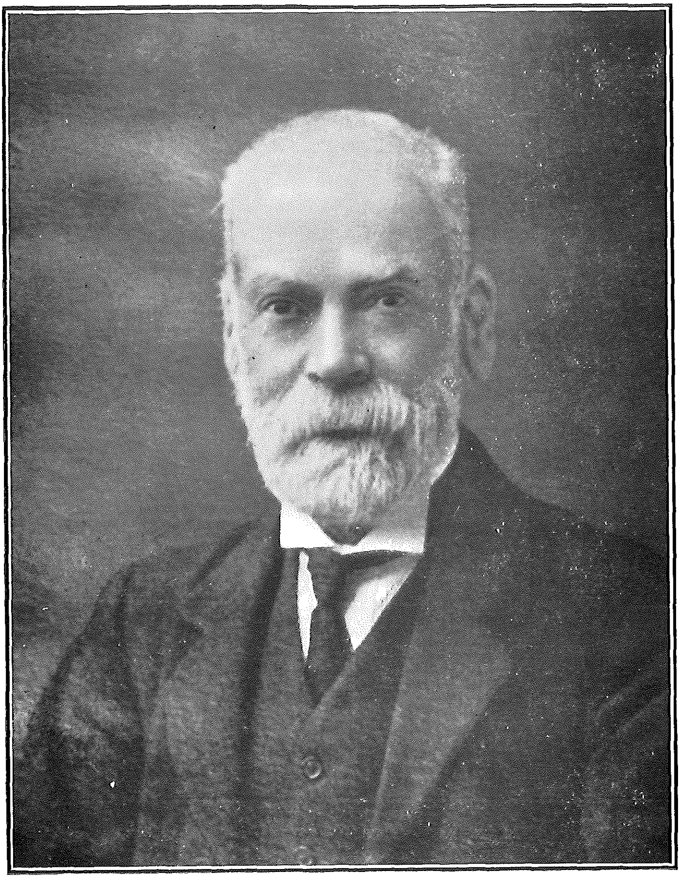


WILLIAM BARCLAY, F.E.I.S., A.L.S.

PRESIDENT OF THE SOCIETY, 1907-1918.

TRANSACTIONS

OF THE

PERTHSHIRE SOCIETY OF NATURAL SCIENCE.

I.—*William Barclay.*

1846—1923.

By George F. Bates.

(Read 11th January, 1924.)

It was with a sense of personal loss that many of us heard, on the 10th of May, 1923, of the death of Mr. Wm. Barclay. He had been for so many years closely associated with us in the affairs of this Society, and was such a prominent and well-known figure in the city of Perth, that his death was felt to be a serious misfortune for the Society, and for the community at large.

Mr Barclay was born at the Tulloch, on the 19th of March, 1846, and was the second oldest of a family of six, one of whom still survives. He received his early education at one of the National Schools* in Perth, and on his decision to follow teaching as a profession, became a pupil-teacher under the late Mr. J. Thomson of Kinnoull.

* There were at that time two National Schools in Perth; one in the New Row and one in Watergate. I have not been able to ascertain which of these Mr. Barclay attended.

At the age of 18 he entered the Church of Scotland Training College at Edinburgh, after taking first place in the entrance examination. On completion of his training he was appointed teacher of Glenrinnes School, Banffshire. Part of his emoluments here consisted of a "glebe," and I remember him telling with great gusto his adventures in taking home his first cow. While at Glenrinnes he married Miss Janet M'Conachie, daughter of a local farmer, whose couthy kindness in later days earned the respect of many friends in Perth.

Mr. Barclay remained at Glenrinnes till 1871, when he was appointed Head Master of Watergate School, Perth, and occupied this post till his removal to the then new Western District School in 1884. Here he remained till his retiral in 1911. The presentations and complimentary dinner which took place on this occasion testified to the high and widespread respect in which Mr. Barclay was held.

On the 3rd of May, 1923, he received the honour of appointment as Associate of the Linnaean Society, and a week later he passed from among us. He was predeceased by Mrs. Barclay on the 12th of December, 1922, and by an only daughter in 1898.

It was as a botanist that Mr. Barclay was best known, and this branch of his numerous activities has been well treated by a former pupil, Mr. J. R. Matthews of Edinburgh, in the "Journal of Botany," for September, 1923. His connection with the Perthshire Society of Natural Science dates from 1883. From 1895 to 1907 he was editor of the Society's *Transactions and Proceedings*, and from 1907 to 1918 he was President of the Society. Curiously enough, fishing, not botany, was his first hobby, but it cannot be denied that botanical science has benefited by the change. He was one of an active band of workers associated with Dr. Buchanan White in the preparation of the Flora of Perthshire, and numerous references to Mr. Barclay are found in that work. After the publication of the Flora he continued his researches, and reference may be made to the Society's *Transactions and Proceedings* for information regarding these.

For the last few years of his life Mr. Barclay took a considerable interest in antiquarian matters, studying largely the Town Council Minutes of by-gone periods, and extracting from them much valuable information. He always required incontrovertible proof of any theory put forward in antiquarian problems; indeed, in such matters, he often took up the attitude of a "doubting Thomas."

Mr. Barclay's activities in the city of Perth were by no means confined to natural science. He took a prominent part in educational matters, and was at one time Secretary and Treasurer of the local branch of the Educational Institute of Scotland. He was for a time a member of the Committee of the Mechanics' Institute, and on the establishment of the Sandeman Library was "taken over" as Convener of the Books Committee, in which post he carried out most valuable duties for a period of 25 years. He was also a Director of the Royal Infirmary and a member of the Royal Horticultural Society of Perthshire.

Mr. Barclay was a regular attender at the excursions of the P.S.N.S., and on these occasions his wide knowledge rendered him a guide, philosopher, and friend to all. His powers of observation were remarkable, and he could discuss intelligently problems in practically any branch of natural science. He was one of a decreasing band of genuine workers, patient, accurate, and with no thought of self-aggrandisement, weighing carefully all the pros and cons of any question under discussion, and forming an opinion thereon which could not easily be upset by further arguments. He at least lived up to the Society's motto in his efforts to "prove all things," and he undoubtedly endeavoured at all times to "hold fast that which is good."

II.—*The Deuchny Hill Fort.*

By Robert R. B. Watson.

(Read 11th January, 1924).

The following observations are more or less tentative and incomplete, and the real value will lie in the survey which is being made by Mr. T. M'Laren, Burgh Surveyor, and the photographs for which I am indebted to Mr. J. Ritchie, Curator of the Museums here.

The site which I shall endeavour to describe occupies the top of what is vaguely shown on the O.S. maps as the Deuchny Hill, and lies to the east of the old hill road between Perth and Dundee, almost at the second milestone. It has an altitude of about 760 feet. In none of the O.S. maps is there any level given above the 700 ft. contour bench mark, and the nearest lies about 500 yards to the N. by W. (magnetic) and is given as 701.6 ft. I learned from Mr. Wilson, factor, Kinfauns Estate, that this top was planted some eighty years ago and the want of details on the O.S. maps was probably due to the density of the trees at that time.

A few years ago the timber was cut and removed, with the result that the hill top was shown to command a singularly wide outlook. From this circumstance and the fact that it is almost entirely rock, it was selected as the alternative site for the Armistice bonfire as against Kinnoull Hill, to which it was preferred as the weather had been dry and the risk of fire great. As it was, the hill top was set on fire, and to this we are probably indebted for the turning up of artifacts which redirected my attention to the spot. Some time before I had noticed what seemed to be lines of placed stones, but the absence of any mention of a site on the O.S. maps made me misdoubt anything more than a possible sheep fold. When a small mortar of stone, however, was brought to the Museum as having been found on the site of the bonfire, I was led to reconsider the question and see what could be made of the site.

It was evident that though the mass of the hill top was rock, there was the more or less continuous remains of a wall of which most of the larger stones were water worn or glaciated, and further that the small stones were chiefly of the same order. Evidently then the wall had not been made at a time when quarrying the stone in the hill was the natural method. Only at one place did it seem as if anything had been done in the rock, and there it was little more than a superficial scratching—but this will be noted in its place. While investigating these worn boulders I noticed certain spots which seem to have been used as hearths and to have been subjected to a long continued heat as there were signs of the stone being almost vitrified. A specimen I brought down and handed to Mr. Ritchie at the Museum shows the action of heat on the upper surface while the lower was buried in the earth. This came from the East end of the North Wall and not far from the gateway. The condition of the stone shows it to have been exposed to heat for a much greater time than the burning of the hill would explain. I have found some five indications of possible fire places.

The walling on both sides seems to have been extra heavy so far as one can judge from the width of the base (foundation you can hardly call it, as nowhere does there seem to have been any sinking). The general plan is the usual local type, the ditch curving round the hill from N.W. and running to the S.E. of the wall line, ending among fairly large boulders which may have been placed so as to break any concerted rush up the slope to the gateway. From the ditch to the gateway are stones set practically in line, and about 10 feet below the gateway the rock crops out. Here the rather disintegrated rock has been scratched into, as already mentioned, so as to even out the line and possibly from a step to trip anyone unused to the line of approach. At the gateway the two wall ends do not face one another squarely, that on the north having a return or incurve so that the inside line of the South wall is about in line with the outside line of the North wall. The south wall keeps along the edge of the hill, with a steep fall of disintegrating rock below it. This wall is fairly well marked for a considerable distance to a slight dip in which the whole wall seems to have slipped down, as one finds stones similar to those in the foundations elsewhere, lower down than the wall line. At this dip ends what looks like a roadway, which follows the South West end of the hill and was used during the cutting of the timber as a road or haulage track. From the placing of the foundation boulders the wall seems to have kept below the shoulder of the hill and to have rested against it, and the whole upper structure to have been thrust out and fallen, leaving a more or less flat surface which later has done service as a " way." This wall probably took below the shoulder (as this is rock and gave no hold or foundation), crossed the dip between the east and middle tops, and followed the edge of the slope to about the west hump, where it curved across the back of the middle hump and joined the south wall of an approach, which runs up the hill S.E. by E., about 5 yards above the lowest sign of walling.

There is a second wall about 16 yards higher up the hill which follows much the same line as the lower, allowing for difference of contour, and which runs into the outer wall at the dip between the middle and eastern tops. This inner wall seems to have been a lighter wall, but as most of the stones are sunk under ground or moss it is more or less indeterminate. The path between the walls running up the middle hump is fairly well defined, and runs on to the western slope of the eastern top where the walls die out.

Between this and the first signs of circumvallation on the north side of the eastern top there is no indication of any walling, the whole being practically bare rock.

Along the line between the gateway at the east and the double wall up the western slope of the hill runs a slight depression, and on it are two moist patches or soaks. (There is another soak on the neck between the middle and eastern tops). When the rest of the hill top was burned out these were untouched, and during wet weather I tried them with a walking stick and found a depth of soft matter of 15 to 18 inches. At the time I had no leave to dig or I should have tried one or two places. This permission I have now received and have here to express my gratitude to Mr. Wilson, factor to the Right Honourable Earl of Moray on the Kinfauns Estate, for his interest in the matter and his free permission to investigate and even excavate. These soaks are the only possible sources of a water supply if such there were. At one time, lower down to N.E. by E., and shown on O.S. maps, was a spring—on the Estate maps called the Butter Well, and famous for its water. Still lower, and along the line of the King's Highway, between Scone and Falkland, and passing by the pre-Reformation Church of Kinfauns, are several other springs. Almost due south (magnetic) of this hill there lies on the march a slope called on the estate plans Whisky Riggs. The hill itself, though marked on the O.S. as Deuchny Hill, is, on old estate plans, marked as Grassy Law, which would indicate that at one time it had been a place of meeting, if not a court. It was also known as the "Seven Airts," seven counties being visible from this top. The slope below the Butter Well was known to old persons as the Rossel or Rostle Bank. (I have this only phonetically, and the present generation know it not).

Any excavation can only be of the slightest, as nowhere does the rock seem far off. To the north east there seems to have been a considerable slide which has filled the ditch. There are few signs of boulder stones round the foot of the hill, but at places there are some as in the gully between the middle and eastern tops and in the ditch about the end of the slide. The line of ditch along the north side of the hill shows boulders on both sides, but as this line was used for timber haulage these may have been shifted to ease the track. To the south east and beyond the ditch are a considerable number of rounded stones which suggest, from the striation, having been placed. Further to the south-east is another top nearly as high which calls for consideration.

But, as said, this is tentative and introductive and with the encouragement and aid I have received I hope to continue the investigation.

Descriptions of articles found are given below. The spots where found are indicated on the plan prepared by Mr. M'Laren.

ARTICLES MARKED ON THE PLAN.

A. Stone mortar made of andesite, found by Mr. J. Henderson on site of bonfire. Size—3 inches by $1\frac{3}{4}$ inches; hollow, $2\frac{1}{8}$ inches by 1 inch. Perth Museum, No. 2164.

B. Hammer stone, white quartzite, cheese shape, 3 inches to $3\frac{1}{4}$ inches by 2 inches. Much battered on edge. Found to south-east between entrance and east soak. Perth Museum, No. 2219.

C. Hammer stone, grey quartzite, pear shape. Battered on small end. Size—$6\frac{3}{4}$ inches by 4 inches by $3\frac{3}{4}$ inches. Found on north slope.

D. There is another hammer stone, granite, which has been split and was found in two portions about 6 feet apart (but still fitting), which are still on the hill. It is much the same as the large pear-shaped grey quartzite one.

E. Jet fragment. Seems to be piece of armlet. Outside curve $1\frac{5}{8}$ inch in length, inside $1\frac{1}{4}$ inch, width $\frac{5}{8}$ inch, thickness $\frac{1}{2}$ inch. The sweep of this fragment would indicate a ring of some $3\frac{7}{8}$ inches in diameter outside, and $3\frac{3}{8}$ inches inside. Found beside a hearth on north wall. Perth Museum, No. 2294.

F. and *G*. Flint and chalcedony, flaked, found on steep slope to south-east outside.

H. Two crystals with seemingly worked ends, and a piece of seemingly worked reddish quartz found on the talus below the last two.

K. Piece of stone, seemingly semi-vitrified, from hearth at east end of fort. The upper surface shows fire action, while the lower, which was buried in earth, is untouched.

L. Pieces of vitrified stone, almost slag, found 24 yards north-west by north from highest point.

M. Four small pieces of calcined bone from slope on south.

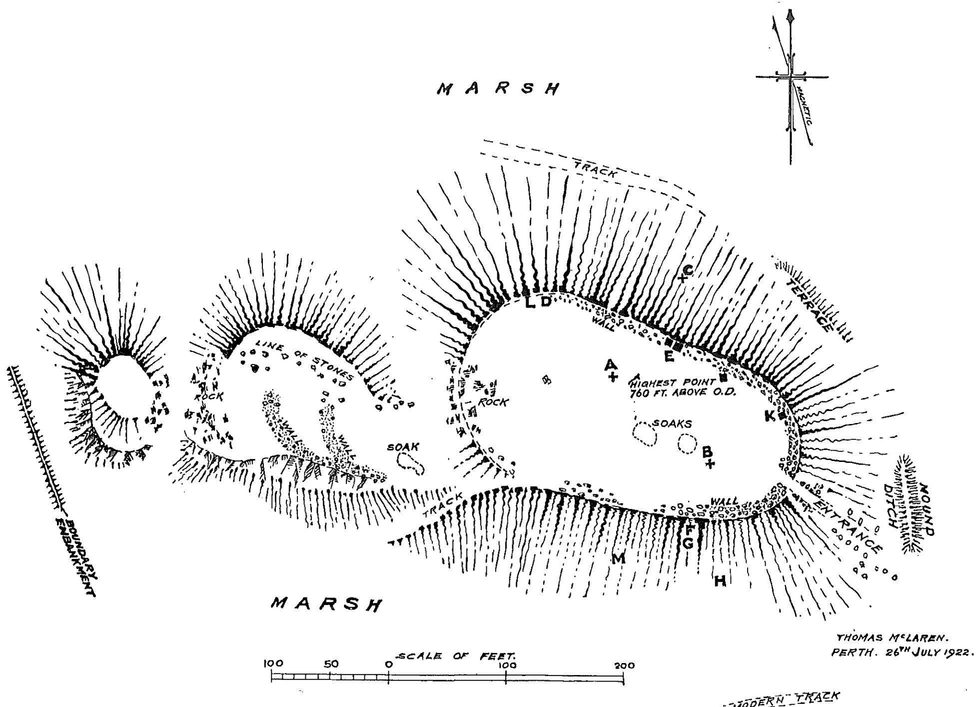


Plate 1—Plan of Fort on Deuchny Hill.

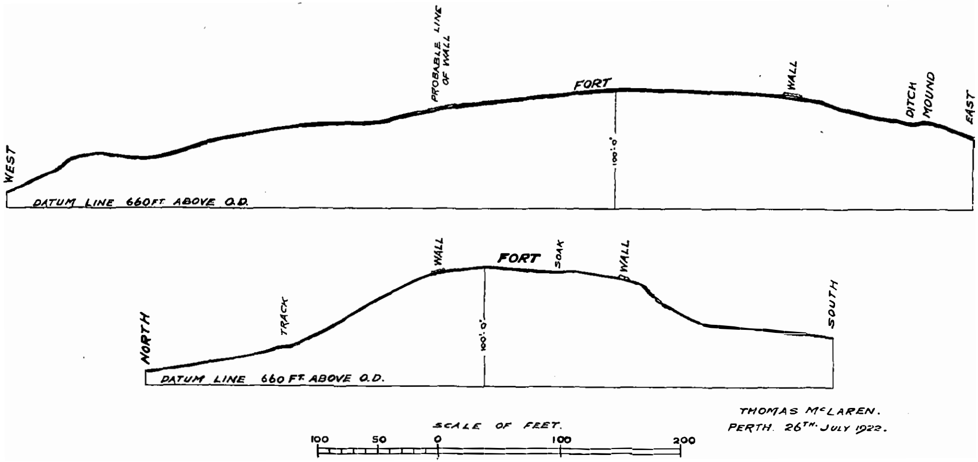


Plate 2—Sections through Fort on Deuchny Hill.

Plate 3—View of Deuchny Hill from East, showing Ditch.

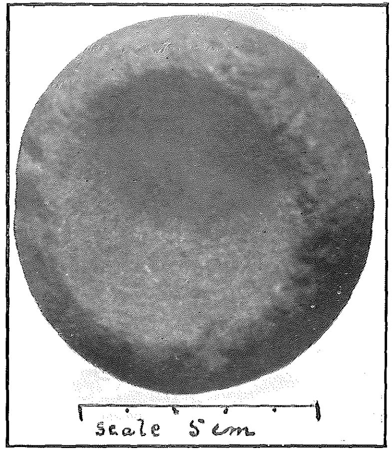


Plate 3 (a)—Andesite Stone Mortar found on the Hill.

Plate 4—View of Deuchny Hill from South West.

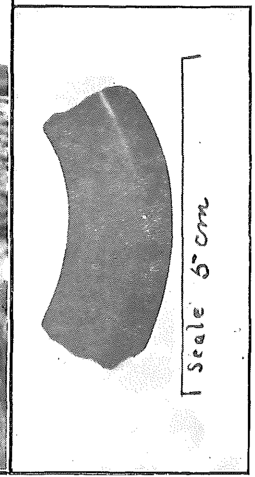


Plate 4 (a)—Jet Fragment found on the Hill.

III.—*Some recent additions to the Discomycetes of Perthshire.*

By JAMES MENZIES.

(Read 11th January, 1924.)

Since the publication of a list of Discomycetes in the *Transactions* of the Society (Vol. VII., part I., page 2), in which were enumerated all the species then known to occur in the county, a few more have been discovered, and these fall to be added to the list. This supplementary list, although not a long one, is of considerable interest and importance. Of the eleven species here recorded one is new to science, four are new to Britain, and two are extremely rare in this country.

Morchellaceae.

MITROPHORA, Leu.

M. hybrida (Low), Boud.
Near mouth of Almond, on sandy soil.

Pezizaceae.

GALACTINIA, Cook.

G. macrospora (Wallr.), Boud.
Scone, on char heaps.

SARCOSCYPHA, Fr.

S. protracta (Fr.), Sacc.
Inver Wood, on sandy soil. *Transactions,* P.S.N.S., Vol. VII., part 3, page 149.

PSEUDOPLECTAMA, Fuck.

P. nigrella (Pers.), Fuck.
Falls of Moness, amongst moss near spruce firs. April, 1923.

Calloriaceae.

AGYRIUM, Fr.

A. rufum (Pers.), Fr.
Kinnoull Hill, on stumps of silver fir.

HYALINIA.

H. turgidella (Karst.), Boud.

Parkfield, on dead grass stems. New to Britain. Trans. Brit. Mycol. Soc., Vol. VII., parts I. and II., page 59.

Lachnellaceae.

DASYSCYPHA, Fr.

D. crystallina (Fuck), Sacc.

Muirhall quarry, on dead stems of Cnicus arvensis and other herbaceous plants. New to Britain. Trans. Brit. Mycol. Soc., Vol. VII., parts I. and II., page 59.

HYALOSCYPHA, Boud.

H. radio-striata (Tellg.), Boud.

Quarry Mill, on dead stems of Symphytum officinale. New to Britain. Trans. Brit. Mycol. Soc., Vol. VI., part IV., page 329.

URCEOLELLA, Boud.

U. leucostoma (Rehm.), Boud.

Tay bank at Barnhill, on dead stems of Oenanthe crocata. New to Britain. Trans. Brit. Mycol. Soc., Vol. VI., part IV., page 329, plate 7.

U. Iridis, Rea.

Methven Loch, on decayed stems of Iris Pseudoacorus. New species. Trans. Brit. Mycol. Soc., Vol. VI., part IV., page 330, plate VII.

Mollisiaceae.

PYRENOPEZIZA, Fuck.

P. millegrana, Boud.

Not uncommon near Perth, as at Quarry Mill, Almond mouth, and Balgarvie Den. On dead stems of Spiraea Ulmaria. New to Britain. Trans. Brit. Mycol. Soc., Vol. VI., part IV., page 330.

IV.—*A Preliminary List of Perthshire Diatoms.*

By George F. Bates, B.A., B.Sc.

(Read 14th March, 1924.)

With the exception of the general paper on Diatoms which I had the honour of reading as my presidential address in 1919, nothing on this subject has appeared in our *Transactions* since 1886, when papers by the late Dr. Trotter were published in Parts V. and VI., Vol. I. Of late years I have given some attention to the Diatoms of the County, and desire now to submit a preliminary list of about 100 species.

Up to the time of writing I have collected chiefly in a limited area of the County. My principal centre has comprised the river Almond and some of the tributary burns on the north bank, but I have besides visited a few Highland lochs, and some localities in the immediate neighbourhood of Perth. A few members of the Society have rendered assistance by collecting in other areas, and further assistance of this kind will be exceedingly welcome.

Diatoms occur almost everywhere, provided that the necessary conditions of water and air are present. They occur as brownish deposits, often of a gelatinous nature, on submerged or wet rocks and stones, or as similar layers at the bottom of water, especially if not in too rapid movement; some species have a moss-like habit of growth, and may be found on rocks and stones exposed to the full forces of a rapidly moving stream; still others are epiphytic on algae or other water plants, and floating "confervae" often have numerous species of diatoms associated with them.

"Pure" gatherings, *i.e.,* those consisting of one species only, have been found by me on comparatively few occasions. As a rule several, if not many, species are found growing together. I have found, pure or nearly so, various species of *Synedra, Gomphonema, Diatoma,* and a few others, but more frequently a gathering may consist of twenty or thirty species.

The identification of Diatoms is often a tedious business. There are species which leap to the eye, so to speak, at a glance; others require careful comparison with figures and type specimens, and after the utmost has been done there often remains an element of uncertainty. Recognised authorities agree that it is quite impracticable to identify Diatoms from verbal descriptions only. A serious difficulty is the rarity, costliness, and inaccessibility of standard works. Professor W. Smith's "Synopsis of British Diatomaceae" is unsurpassed for the excellence of its plates, but it was published in 1856, and its text can hardly be regarded as up-to-date. Another work of great promise was Donkin's "British Diatomaceae," but unfortunately the publication came to an end with the third part, owing to the death of the author. The three parts published deal with the genus Navicula, and the twelve plates are of a very high standard. Mills and Philips' "Diatomaceae of the Hull District," published in the "Transactions" of the Hull Scientific and Field Naturalists' Club for 1901, contains sixteen extremely useful plates. An almost indispensable book, however, is Van Heurck's "Traité des Diatomées," published at Antwerp in 1899, or its English equivalent. This work describes and illustrates the Diatoms of the North Sea and surrounding countries, and includes some thirty-five plates and numerous figures in the text.

According to the latest edition of the Encyclopædia Britannica 10,000 species of Diatoms have been described, while 1,200 species and numerous varieties occur on the coasts or in the fresh waters of Britain. In view of the varied nature of Perthshire localities, the number of species existing in the county may reasonably be expected to be very considerable, and the publication of a list of 100 species must be regarded merely as the first step in what must necessarily be a long and arduous investigation.

It follows from what has been said above regarding the known number of Diatoms that the classification cannot be a simple matter. The older classifications were to some extent based upon what the more recent investigators regard as unimportant characters, though curiously enough two of the older observers noted characters on which two of the modern classifications are based. Thus W. Smith, in his Synopsis, notes the constancy of the arrangement of the endochrome, in granules or lamellae, in the various species—a character on which the classification of Pfitzer and Petit is based, and in 1861 Ralfs published a system based on the presence or absence of a raphé, which was subsequently developed by H. L. Smith, a well-known American diatomist, and by Van Heurck.

Three systems of classification hold the field to-day :—

(1) The system of Schütt, based on valve-characters. The primary division under this system is into *Pennatae* and *Centricae,* according to the symmetry of the valve markings on each side of a median line, or about a central point.

(2) The system of Pfitzer and Petit, based upon the characters of the endochrome. The primary division here is into *Placcochromeae* (endochrome in plates, or lamellae), and *Coccochromeae* (endochrome in granules). Each of these sub-orders is divided into tribes, and the tribes into genera. The weakness of this system is

that it is applicable only in a limited sense to fossil genera—these must be described and classified from their valve characters, in the same way as a fossil animal from its skeleton.

(3) The system of H. L. Smith, as developed by Van Heurck. The primary classification in this system is as follows:—

- (i.) Sub-Order *Rhaphideae,* consisting of genera one or both of whose valves show a true raphé, *i.e.,* a longitudinal line, median or approximately so, commonly with terminal and median nodules.
- (ii.) Sub-Order *Pseudo-Raphideae,* genera whose valves show a clear space, resembling a true raphé.
- (iii.) Sub-Order *Crypto-Raphideae,* genera whose valves show neither a true nor a false raphé.

Associated with the presence or absence of raphé there are usually other characteristics of shape, etc.

These sub-orders are divided into cohorts, tribes, etc., and finally into genera.

In the following list I have followed the classification of Van Heurck, also his nomenclature. In view of the numerous systems of classification which have been proposed, it is not surprising to find that synonyms are exceeding numerous, and that even generic names have disappeared from the more modern lists. Thus several writers make no distinction between the genera *Pinnularia* and *Navicula,* and have entirely dropped the former as a generic name, and the same applies to *Cocconeis* and *Cymbella.*

I have not at this stage named any definite localities. Most of the species listed are very common—in less than a dozen cases has the particular species been found in not more than one gathering.

NATURAL ORDER *DIATOMACEAE*.

I. SUB-ORDER *Raphideae.*

Tribe *Cymbelleae.*

Amphora ovalis, Kütz.
Cymbella Ehrenbergii, Kütz.
C. lanceolata, Ehr.
C. cuspidata, Kütz.
,, ,, *var.* naviculiformis.
C. cymbiformis, Ehr.
C. cistula, Hempr.
C. Helvetica, Kütz.
Encyonema prostratum, Ralfs.
E. caespitosum, Kütz.

Tribe *Naviculeae.*

Stauroneis Phœnicenteron, Ehr.
S. acuta, W. Sm.
S. anceps, Ehr.
S. Smithii, Grun.
Navicula major, Kütz.
N. viridis, Kütz.
N. alpina, Ralfs.
N. divergens, W. Sm.
N. Brébissonii, Kütz.
N. gibba, Kütz.
,, ,, *var.* brevistriata.
N. subcapitata, Greg.
N. bicapitata, Lagerstedt.
N. mesolepta, Ehr.
N. Legumen, Ehr.
N. Prætexta, Ehr.
N. Tuscula, Ehr.
N. polyonca, Bréb.
N. oblonga, Kütz.
N. radiosa, Kütz.
,, ,, *var.* acuta (=Pinnularia acuta, W. Sm.).
N. rhyncocephala, Kütz.
N. lanceolata, Kütz.
N. dicephala, W. Sm.
N. interrupta, Kütz.
N. elliptica, Kütz.
N. ambigua, Ehr.
N. sphaerophora, Kütz.
N. limosa, Kütz.
,, ,, *var.* gibberula (=N. gibberula, Kütz).
N. Iridis, Ehr.
,, ,, *var.* amphirhyncus, Ehr.
,, ,, *var.* affinis (=N. affinis, Ehr.).
,, ,, *var.* producta (=N. producta, W. Sm.).
Vanheurckia rhomboides, Bréb.
,, ,, *var.* crassinervis (=Navicula crassinervia, Bréb.).
Pleurosigma angulatum, W. Sm. *var.* strigosum. (=P. strigosum, W. Sm.).
P. attenuatum, W. Sm.
P. acuminatum (Kütz), Grun.

Tribe *Gomphonemeae.*

Gomphonema geminatum, Ag.
G. constrictum, Ehr.
,, ,, *var.* capitatum
(=G. capitatum, Ehr.).
G. acuminatum, Ehr.
G. intricatum, Kütz.
Rhoicosphenia curvata (Kütz.), Grun.

Tribe *Achnantheae.*

Achnanthidium flexellum, Bréb.
Achnanthes exilis, Kütz.

Tribe *Cocconeideae.*

Cocconeis Placentula, Ehr.

II. SUB-ORDER *Pseudo-Raphideae.*

Tribe *Epithemieae.*

Epithemia turgida (Ehr.), Kütz.
E. Hyndmanni, W. Sm.
E. sorex, Kütz.
E. gibba, Kütz.
,, ,, *var.* ventricosa (=E. ventricosa, Kütz.).
E. Argus, Kütz.
E. zebra (Ehr.), Kütz.
Eunotia gracilis (Ehr.), Rab.
E. major (W. Sm.), Rab.
E. pectinalis (Kütz.), Rab.
E. triodon, Ehr.
E. lunaris (Ehr.), Grun.
E. robusta, Ralfs., *var.* tetraodon
(=E. tetraodon, Ehr.).
Ceratoneis Arcus, Kütz.

Tribe *Synedreae.*

Synedra Ulna (Nitzsch.), Ehr.
,, ,, *var.* splendens
(=E. splendens, Kütz.).
S. Acus (Kütz.), Grun.

Tribe *Fragilarieae.*

Fragilaria virescens, Ralfs.
F. mutabilis (W. Sm.), Grun.
F. capucina, Desm.

Tribe *Meridioneae*.

Meridion circulare, Ag.
,, ,, *var.* constrictum
(=M. constrictum, Ralfs.).

Tribe *Diatomeae*.

Diatoma vulgare, Bory.
D. hyemale (Lyngb.), Heib.
,, ,, *var.* mesodon
(=Odontidium mesodon, Kütz.).
D. elongatum, Ag.
Denticula tenuis, Kütz.

Tribe *Tabellarieae*.

Tetracyclus lacustris, Ralfs.
Tabellaria fenestrata (Lyngb.), Kütz.
T. flocculosa (Roth.), Kütz.

Tribe *Surirelleae*.

Cymatopleura elliptica (Bréb.), W. Sm.
C. Solea (Bréb.), W. Sm.
Surirella biseriata, Bréb.
S. linearis, W. Sm.
S. robusta, Ehr.
,, ,, *var.* splendida (=S. splendida, Kütz.).
S. ovalis, Bréb., *var.* ovata (=S. ovata, Kütz.).
,, ,, *var.* pinnata (=S. pinnata, W. Sm.).
S. spiralis, Kütz.

Tribe *Nitzschieae*.

Hantzschia Amphioxys (Ehr.), Grun.
Nitzschia sigmoidea (Ehr.), W. Sm.
N. sinuata (W. Sm.), Grun.
N. sigma, W. Sm.

III. SUB-ORDER *Crypto-Raphideae*.

Tribe *Melosireae*.

Melosira varians, Ag.
M. arenaria, Moore.

Tribe *Heliopelteae*.

Actinoptychus undulatus (Ehr.), Ralfs.

Tribe *Coscinodisceae*.

Coscinodiscus radiatus, Ehr.

V.—*Catalogue of the Conchological Collections in the Perthshire Natural History Museum.*

By HENRY COATES, F.S.A.Scot.

(Read 13th February, 1925.)

INTRODUCTION.

The Conchological Collections in the Perthshire Natural History Museum now comprise about 1,600 species of recent Mollusca, represented by at least 20,000 specimens. This may seem a small proportion of the 60,000 species known to be living at the present time, but the range is wide and representative, both systematically and geographically. The species are spread over nearly all the families, and a large number of the genera; while the specimens have been collected from all the continents and all the oceans. In particular, all parts of the British coasts are represented, as well as many of the British Vice-comital Regions, and all districts of Perthshire.

The various collections at present housed in the Perthshire Museum comprise the following series:—1, a Perthshire Series (necessarily all Land and Freshwater); 2, a British Marine Series; 3, a British Land and Freshwater Series; and 4, a General Series, comprising both British and Foreign species. The first three of these series will be found in cabinets under the desk cases of the Perthshire Gallery, while the General Series is stored in cabinets in the Index Museum. In addition to these there is a small Display Collection of Perthshire species in the desk cases of the Perthshire Gallery; and a small Display Collection of General Conchology in table cases in the Index Museum. In upright cases above these table cases is displayed a typical collection illustrating the structure and development of the Mollusca; and another illustrating Economic Conchology. The reference collections in the cabinets are intended more especially for students, who can at all times obtain access to them on application to the Curator.

In the following Catalogue all these different series are combined in one General Series, so as to show the true position of the Perthshire and British species in the general scheme of classification of the Mollusca.

The collections in the Museum have been acquired and enriched from many different sources, and at various times. The foundation was the collection of Perthshire and British species made by the late Dr. Buchanan White, some of which he gave to the Museum shortly after it was opened, while the remainder were handed over by his widow after his death. These included specimens collected by other three of the Founders of the Society, Messrs. William Herd, John Dawson, and James M'Farlane.

In 1900 the present writer handed over to the Museum the whole of his own collections of shells, Perthshire, British, and Foreign; marine, land, and freshwater. Since that date he has added to the collections all the specimens he has acquired, either as the result of his own collecting, or by exchange with others. These collections embrace all the specimens he has gathered during more than fifty years of field work, besides many collected by his father, the late Mr. Andrew Coates, in the Mediterranean; by his brother, the late Mr. James Coates, around the British coasts, and in several parts of the Continent; by the late Miss Mackinlay, at Algiers; by the late Mrs. Roberts, at Suez, on the Red Sea; and by the Rev. Fred. Smith, in the Forth and Clyde, in Cambridgeshire, and in France and Germany.

In 1897 a fine collection of foreign shells, gathered by the late Viscountess Strathallan, was presented by her to the Museum; and in 1911, after her death, the remainder of her collection was handed over by her representatives. These embrace some 340 species, mostly from the Eastern Seas, and all in excellent condition. In 1910 Mr. Charles Masterson presented a collection of 93 species from British Guiana, in South America, collected by the Rev. Mr. Chalmers. In 1901 Mrs. Paterson, of the New Hebrides, presented a representative collection of some of the smaller species of Mollusca from these Islands.

The present writer has also been able to acquire, for the Museum, collections of Andean land and freshwater shells, from Mr. L. Söderstrom, British Consul in Ecuador; a collection of West Indian shells, sent home by the Rev. R. N. Dixon, of the Grand Cayman Island; a miscellaneous collection of foreign shells, got together by the late Mr. Thomas Reid, Perth; and a number of rare British shells, collected by the late Mrs. Paull, of Perranwell, Cornwall. These last were got by way of exchange with the Royal Cornwall Museum, Truro. Similarly a number of interesting species, principally foreign, have been added to the collection by exchange with the Natural History Museum of University College, Dundee. Others have been obtained by exchange with Mr. W. Gyngell, of Scarborough, to whom I am also indebted for valuable assistance in revising the sheets of the present Catalogue.

The British Marine series has been enriched by a number of rare species which were dredged in the Firth of Clyde by the late Dr. David Robertson, of the Millport Marine Station, Cumbrae, and presented to the Museum, after his death, by his widow. The Perthshire Land and Freshwater Series was added to by several enthusiastic members of the Junior Section of the Perthshire Society of Natural Science, including Mr. Fred. Smith, Jun., Mr. James Leslie, and the late Mr. William Wyllie. Some of the most interesting specimens in the General Series were certain of those dredged and brought home by the "Challenger" Expedition, and presented to the Museum by the Trustees of the British Museum.

When the museum of the Perth Literary and Antiquarian Society was taken over by the Municipal Authority, the conchological collections of the Perthshire Museum received two valuable augmentations. These consisted of, first, a fine collection of foreign shells, which had been presented to the Society by Dr. John Ogilvie, as early as 1825; and, second, a small collection of British Marine shells, most of them got in the neighbourhood of St. Andrews, by Dr. W. C. M'Intosh, Professor of Natural History there. The foreign shells, numbering 260 species, although so old, were, when freed from the accumulated dust of years, found to be in excellent condition, and were all carefully named and catalogued.

In addition to the shells embraced in the various collections, there is a small but typical series of specimens of Mollusca mounted as wet preparations, in spirit and formalin. These include a series of British species, prepared at the Marine Biological Station, Millport, and presented to the Museum by the late Mr. James Coats, Jun., Paisley; also a number of Arctic species, brought home by the Captains of various Dundee whaling vessels.

To collate, incorporate, arrange, mount, name and catalogue all these various collections has involved the labour and study of several years, but the result, as attested by the following Catalogue, is a collection which will compare favourably with the conchological collections to be found in any other provincial museum in the country.

It may interest museum curators to know that practically all the larger specimens—but not the very largest—are placed loose in rectangular glass-topped boxes, of multiple sizes. This, although the most expensive, is much the most satisfactory method of preservation, for the specimens are not only kept free from dust, but they can be taken out at any time for examination, or exchanged for better specimens. Many of the minute specimens were preserved in small glass test tubes, corked with a wad of cotton-wool, but this method is not to be commended. When moisture from the atmosphere condensed on the inside of the glass it did not readily dry up, and delicate shells were apt to crumble into shapeless fragments of lime. To obviate this risk the plan adopted was to place such shells in small glass-topped pill boxes, which were pinned down to wooden tablets, at the foot of which the label was fixed.

If this Catalogue should meet the eyes of any fellow-members of the Museums Association, or of the Conchological Society of Great Britain and Ireland, may I express the hope that those who have duplicates to spare, which would fill up any of the blanks in the list, will communicate either with the curator or myself, at the Perthshire Natural History Museum, Tay Street, Perth.

In adopting a scheme of classification for the purposes of the following Catalogue, I have endeavoured to steer a middle course between the two extremes of, first, the too large and unwieldy groups adopted by the earlier naturalists, when the number of known species was smaller, and our knowledge of structural detail more limited; and, second, the tendency to multiply the sub-division of groups, and to introduce a bewildering variety of new names. In the main, I have followed the classification adopted by the Rev. A. H. Cooke, M.A., D.Sc., in his volume on "Molluscs," in the Cambridge Natural History, published in 1895. In order, however, to bring the scheme more up to date, I have introduced certain modifications, based on the recent new edition of the "Guide to the Mollusca exhibited in the British Museum (Natural History)," by Mr. G. C. Robson, M.A., published in 1923. The Amphineura (Chitons), for instance, are raised from an Order to a Class. Also, the order Pulmonata is broken up into a larger number of families.

As regards nomenclature, I have followed the Law of Priority as far as possible, but where the original names were unfamiliar to the ordinary student I have added the more familiar synonyms in square brackets. This applies both to generic and specific names. For the British Marine species, I have adopted the names given in the "List of British Mollusca" prepared by a committee of the Conchological Society of Great Britain and Ireland, Second Edition, published in 1902. For British Land and Freshwater species, I have adopted the names and classification given by Messrs. A. S. Kennard, F.G.S., and B. B. Woodward, F.L.S., in their "List of British Non-Marine Mollusca," published in 1914.

For the nomenclature of foreign species I have had no single up-to-date authority to guide me, but have had to rely mainly on H. and A. Adams' "Genera of Recent Mollusca," published in 1858, and J. C. Chenu's "Manuel de Conchyliologie et Paléontologie Conchyliologique," published on 1859-62, as well as such other books and papers as I had access to, including the "Lists of Recent

Mollusca," issued by Mr. Hugh C. Fulton. I must therefore claim the indulgence of readers in regard to any discrepancies of nomenclature, and would further ask them kindly to point out to me any examples of such that they may come across. The fact is that a thoroughly comprehensive book, giving a complete survey of the Mollusca as at present understood by students of systematic zoology, has yet to be written.

In the following Catalogue, the figures in the first column represent the Registered Numbers in the Card Index of the Perth Museum. The figures given after the names of the British [Marine] species are those of the Conchological Society's List of 1902. The figures after the names of the British Land and Freshwater species are those of Messrs. Kennard and Woodward's List of 1914. Lastly, the figures after the names of the Perthshire species are those given in my paper on "The Land and Freshwater Mollusca of Perthshire," published in the *Transactions* of the Perthshire Society of Natural Science in 1922 (Vol. VII, page 179).

Phylum **MOLLUSCA** (Soft-bodied Invertebrates).

Class CEPHALOPODA (" Head-footed ").

Order **DIBRANCHIATA** (Two Branchiæ).

Sub-order *OCTOPODA* (" Eight-footed ").

Fam. Argonautidae.

469.	Argonauta argo, *Linné*.	Japan Sea. Mediterranean. [The " Paper Nautilus."]
476.	A. tuberculata, *Rafinesque*.	do.

Sub-order *DECAPODA* (" Ten-footed ").

Fam. Spirulidae.

504.	Spirula peronii, *Lam.* [=prototypus].	(*British*, 712). Pacific Ocean. Fiji Islands. (Sometimes cast up on British Coasts.)

Fam. Sepiidae.

470.	Sepia officinalis, *Linné*.	(*British,* 716). Algiers.

Order **TETRABRANCHIATA** (Four branchiæ).

Fam. Nautilidae.

1.	Nautilus pompilius, *Linné*.	Indian Seas. [The " Pearly Nautilus."].
754.	N. macromphalus, *Sow*.	Singapore.
1424.	N. umbilicatus, *Lister*.	New Ireland.

Class AMPHINEURA (Shell in eight segments).

Order **POLYPLACOPHORA** (Normal multivalves).

Fam. Chitonidae.

1575.	Lepidopleurus [=Chiton] cancellatus (*Sow.*).	(*British,* 6). Jersey, Channel Islands.
1576.	Tonicella [=Chiton] marmorea (*Fabr.*).	(*do.* 9). Oban.

345. Callochiton [=Chiton] lævis, *Mont.* (*British*, 11). Granton, Forth.
500. Craspedochilus [=Chiton] cinereus (*Linné*) [=marginatus]. (*do.* 13). St. Andrews. Helford River, Cornwall.
501. Acanthochites [=Chiton] facicularis (*Linné*). (*do.* 15). St. Andrews. Tenby, Wales.
406. A. discrepans (*Brown*). (*do.* 16). Herm, Channel Islands.
1135. Acanthopleura gigas, *Chem.*

Class GASTEROPODA (" Stomach-footed ").

Order **PROSOBRANCHIATA** (Branchiæ in front of the heart).

Section *DOCOGLOSSA* (Radula very long; few teeth in each row).

Fam. Acmæidae.

484. Acmæa [=Tectura] testudinalis, *Müll.* (*British*, 277). Deerness, Orkney. Corrie, Arran. Granton, Forth.
1142. A. virginea (*Müll.*). (*do.* 278). Deerness, Orkney. Falmouth and Helford River, Cornwall.
473. A. crucis, *Ten-Woods.* Tasmania.
479. A. leucopleura, *Gmel.* Florida.
483. A. sacharina, *Linné.*
545. A. carpenteri, *Pilsbury.* West Indies.

Fam. Patellidae.

481. Patella vulgata, *Linné.* (*British*, 274). Forth. Clyde. Cornwall. Portrush, Ireland. Deerness, Orkney.
var. picta, *Jeff.* Kent.
var. intermedia, *Knapp.* Jersey, Channel Islands.
1141. P. depressa, *Penn.* [=athletica]. (*British*, 275). St. Andrews. Cornwall.
203. P. variabilis, *Krauss.* South Africa.
474. P. aspera, *Lam* Pozzuoli, Italy.

478.	P. rota, *Chem.*	Suez.
480.	P. lusitanica, *Gmel.*	Sicily.
1137.	P. umbella, *Gmel.*	East London, South Africa.
477.	P. (Scutellastra) pentagona, *Born.*	Palmerston Island.
426.	P. (S.) plicata, *Born.*	
427.	P. (S.) longicosta, *Lam.*	South Africa.
428.	P. (Cymbulum) compressa, *Linné.*	do.
802.	P. (Olana) cochlear, *Gmel.*	do.
482.	Helcion pellucida (*Linné*).	(*British*, 276). Deerness, Orkney. Clyde. Forth. Tenby, Wales. Cornwall. Portrush, Ireland.
	var. laevis, *Penn.*	Troon. North Berwick. Cornwall.
472.	Scutellina ferruginea, *A. Adams.*	Algiers.

Section *RHIPIDOGLOSSA* (Radula long, marginals multiplied).

Fam. Fissurellidae.

1375.	Puncturella noachina (*Linné*).	(*British*, 282). Shetland.
495.	Fissurella græca (*Linné*).	(*British*, 286). Lochmaddy, North Uist. Falmouth. Weymouth. Herm, C.I. Portrush.
485.	F. crassa, *Lam.*	Valparaiso, Chili.
487.	F. nubecula, *Linné.*	Algiers.
488.	F. pustulata, *Lam.*	
492.	F. (Cremides) nodosa, *Born.*	Grand Cayman, West Indies.
486.	F. (Lucapina) cancellata, *Soland.*	
489.	F. (L.) incei, *Reeve.*	
490.	F. (L.) crenulata, *Sow.*	San Pedro, California.
491.	F. (L.) dysoni, *Reeve.*	
498.	Emarginula fissura (*Linné*).	(*British*, 283). Deerness, Orkney. John o' Groats. St. Andrews. North Berwick. Torbay. Herm. Portrush.
1143.	E. conica, *Schum.* [=rosea].	(*do.* 284). Herm, Channel Islands.

Fam. Haliotidae.

499. Haliotis tuberculata, *Linné*.	(*British*, 288). Guernsey, etc., Channel Islands.
199. H. splendens, *Reeve*.	California.
200. H. kamtschatkana, *Jonas*.	Kamtschatka.
201. H. varia, *Linné*.	Philippine Islands.
423. H. gibba, *Phil.*	Bank's Peninsula, South Island, New Zealand.
424. H. midae, *Linné*.	St. Paul's Bay, Malta. Syracuse. Algiers.
425. H. funebris, *Reeve*.	
502. H. (Padollus) dringii, *Reeve*.	Andaman Islands. New Hebrides.
503. H. (P.) nævosa, *Martyn*.	New South Wales.
202. H. (Teinotis) asinina, *Linné*.	Australia.

Fam. Stomatellidae.

422. Stomatella imbricata, *Lam*.	Australia.

Fam. Liotiidae.

506. Liotia varicosa, *Reeve*.	Lifu. Loyalty Islands.
507. L. (Arene) muricata, *Humph.*	do. do.

Fam. Trochidae.

510. Trochus acutangulus, *Chem.*	Suez. Philippine Islands.
519. T. niloticus, *Linné*.	Suez. Torres Straits.
405. T. virgatus, *Gmel.*	Red Sea.
1376. Eumargarita [=Trochus] helicina (*Fab.*).	(*British*, 290). Shetland.
404. Tectus triserialis, *Lam.*	
413. Polydonta flamulata, *Lam.*	Seychelles.
190. P. maculata, *Linné*.	Indo-Pacific Ocean. Mauritius.

515.	P. viridis, *Chem.*	Colombo.
1207.	P. radiatus, *Gmel.*	Zanzibar.
411.	P. (Infundibulum) saga, *Phil.*	Suez.
189.	P. (I.) carinifera, *Beck.*	China Sea.
191.	Clanculus puniceus, *Phil.*	Senegal. Zanzibar.
520.	C. personatus, *Phil.*	Australia.
1209.	C. plebius, *Phil.*	South Australia.
535.	C. pharaonis, *Lam.*	Suez.
409.	Monodonta circumcincta, *Adams.*	Lido, Venice.
532.	M. canalifera, *Lam.*	St. Paul's Bay, Malta.
537.	M. crassa (*Mont.*) [=lineatus].	(*British*, 299). Tenby, Wales. Falmouth. Tresco, S.I. Jersey, C.I.
516.	M. multicarinata.	Australia.
543.	Euchelus indicus, *A. Adams.*	Bushire, Persian Gulf.
522.	E. persicus, *Martyn.*	Kurrachee.
514.	Thalotia cònica, *Gray.*	Rockhampton, Queensland.
508.	Calliostoma [=Trochus] montagui (*W. Woods*).	(*British*, 300). Helford River, Cornwall. Herm, C.I. Algiers.
1144.	C. striatum (*Linné*).	(*do.* 301). Helford River, Cornwall. Herm, C.I.
1145.	C. exasperatum, (*Penn.*).	(*do.* 302). Tenby, Wales. Herm, C.I.
1146.	C. miliare (*Brocchi*) [=millegranus].	(*do.* 303). Cumbrae, Firth of Clyde.
1377.	C. granulatum (*Born*).	(*do.* 304). Channel Islands.
536.	C. ziziphinus (*Linné*).	(*do.* 305). Deerness, Orkney. Cumbrae. Forth. Falmouth. Tresco, S.I. Herm, C.I. Portrush, Ireland.
	var. lyonsi, *Leach.*	St. Andrews.
1205.	C. speciosum, *A. Adams.*	Australia.
513.	C. decoratus, *Phil.*	Port Jackson, Sydney (Chal. Exped.).
192.	C. canaliculatus, *Martyn.*	New Zealand.
531.	C. conulus, *Linné.*	Pozzuoli, Italy.
1213.	Bankivia varians, *Beck.*	New Zealand.

198.	Trochocochlea multicarinata, *Lam.*	Tasmania.
528.	T. tæniata, *Quoy and Gaim.*	New Hebrides.
193.	Oxystele merula, *Chem.*	South Africa.
194.	O. tigrina, *Chem.*	do.
195.	O. impervia, *Menke.*	do.
196.	O. tabularis, *Krauss.*	do. Rockhampton, Queensland.
512.	Photinula taeniata, *Wood.*	Falkland Islands (Chal. Exped.).
1212.	Chlorostoma argyrostoma, *Gmel.*	Japan.
197.	C. pulligo, *Martyn.*	California.
527.	Omphalius excavatus, *Lam.*	New Hebrides.
285.	O. fasciatus, *Born.*	Grand Cayman, W.I.
540.	Gibbula [=Trochus] magus (*Linné*).	(*British*, 295). Lochmaddy, North Uist. Troon. Helford River, Cornwall. Herm, C.I.
539.	G. tumida (*Mont.*).	(*do.* 296). Cumbrae. Corrie, Arran. Firth of Forth.
406.	G. cineraria (*Linné*).	(*do.* 297). St. Andrews. Aberdour, Forth. Falmouth and Helford River, Cornwall.
408.	G. umbilicata (*Mont.*).	(*do.* 298). Troon. Torquay. Falmouth. Herm, C.I. Deerness, Orkney.
530.	G. (Forskalia) declivis, *Forsk.*	Suez.
1208.	Odontotrochus chlorostomus, *Menke.*	Australia.
1211.	Norrisia norrisi, *Sow.*	San Diego.
533.	Vitrinella tricarinata.	Madras.
188.	Umbonium vestiarium, *Linné* [=Rotella lineolata, *Lam.*].	Madras. China. Australia.
1214.	Elenchus fulmineus, *Kiener.*	Australia.
415.	Livona pica, *Linné.*	Bahamas.

Fam. Cyclostrematidae.

1619.	Delphinoidea [=Cyclostrema] nitens (*Phil.*).	(*British*, 312). Exmouth.
1620.	D. serpuloides (*Mont.*).	(*do.* 313). do.

Fam. Turbinidae.

421.	Phasianella pullus (*Linné*).	(*British*, 321). Deerness, Orkney. Troon. Falmouth and Porthcurnow, Cornwall. Algiers.
553.	P. australis, *Desh.*	Australia (Chal. Exped.).
554.	P. ventricosa, *Quoy and Gaim.*	do.
556.	P. kochi, *Phil.*	East London, South Africa.
1215.	P. bulimoides, *Lam.*	
1216.	P. aethiopica, *Phil.*	Zanzibar.
1218.	P. solida, *Born.*	
1217.	Phasianotrochus leucostigma, *Menke.*	Australia.
260.	Turbo olearium.	
184.	T. petholatus, *Linné.*	Philippine Islands. New Hebrides.
420.	T. carduus, *Fischer.*	Pacific Islands.
416.	Senectus margaritaceus, *Linné.*	
417.	S. radiatus, *Gmel.*	New Hebrides.
549.	S. chrysostomus, *Linné.*	Reef of Tongalabu (Chal. Exped.)
550.	S. nivosus, *Reeve.*	Suez.
185.	S. spinosus, *Chem.*	Indian Ocean.
548.	S. chemnitzianus, *Reeve.*	Suez.
418.	Lunella porphyrites, *Martyn.*	Philippine Islands.
	var. versicolor.	do.
186.	L. coronatus, *Gmel.*	Natal.
1220.	Ninella torquatus, *Reeve.*	
1241.	Stella laciniata, *Gould.*	China.
410.	S. papillata, *Pot. and Mich.*	Grand Cayman, West Indies
187.	Callopoma fluctuosum, *Wood.*	California.
414.	C. fluctuatum, *Gray.*	
558.	Pachypoma rhodostoma, *Phil.*	Sophia Islands
559.	P. longispina, *Lam.*	West Indies.

1219.	P. cælatum, *Chem.*	
419.	Lithopoma tuber, *Linné.*	Guadaloupe.
1210.	Pomaulax undosum, *Wood.*	California.

Fam. Neritopsidae.

560.	Neritopsis radula, *Linné.*	Lifu, Loyalty Islands.

Fam. Neritidae.

176.	Nerita quadricolor, *Glemin.*	Red Sea.
177.	N. polita, *Linné.*	Suez. Pacific Islands.
178.	N. rumphii, *Recluz.*	Philippine Islands.
562.	N. erythrœa.	Aden.
564.	N. marmorata.	Suez. Fiji Islands.
565.	N. tessellata, *Gmel.*	Grand Cayman, West Indies.
566.	N. versicolor, *Lam.*	Florida.
400.	N. (Pila) peloronta, *Linné.*	Bahamas.
563.	N. (P.) plicata, *Linné.*	Palmerston Island.
561.	N. (Theliostyla) albicilla, *Linné*	Mauritius. Ceylon.
175.	N. (T.) plexa, *Chem.*	Comoro Island.
179.	N. (T.) exuvia, *Linné.*	Philippine Islands.
180.	Neritina cornea, *Linné.*	do.
181.	N. zigzag, *Lam.*	do.
182.	N. lineolata, *Lam.*	Para.
183.	N. zebra, *Linné.*	Tahiti.
570.	N. melanensis, *Less.*	
573.	N. michonii.	Elijah's Spring, Mount Carmel.
574.	N. smithii, *Gray.*	
576.	N. tristis, *D'Orb.*	New Hebrides.
577.	N. labiosa, *Sow.*	Java.

1225.	N. semiconica, *Lam.*	
568.	N. (Vitta) fluviatilis, *Linné.*	(*Brit. L.* and *F.-W.*, 177). R. Somme, Abbeville.
402.	N. (V.) pupa, *Linné.*	Grand Cayman, West Indies.
401.	N. (V.) virginea, *Lam.*	Jamaica.
403.	N. (V.) viridis, *Linné.*	do.
569.	N. (V.) picta, *Sow.*	West Coast of Mexico.
572.	N. (Dostia) crepidularia, *Lam.*	Calcutta.
575.	N. (Alima) jordani, *Sow.*	Sea of Galilee.

Fam. Hydrocenidae.

578.	Hydrocena fischeri, *Gassies.*	Lifu, Loyalty Islands.

Fam. Helicinidae.

579.	Helicina (Alcadia) brownii, *Gray.*	Jamaica.
580.	H. (Trochatella) pulchella, *Gray.*	do.
766.	Bourciera helicinæformis, *Pfeiffer.*	Pichincha, Ecuador. (Peculiar to Ecuador and only species of the genus.)

Section *PTENOGLOSSA* (Radula with teeth similar throughout; outermost largest).

Fam. Ianthinidae.

261.	Ianthina communis, *Lam.* [=fragilis].	(*British*, 393). Hebrides.
407.	I. exigua, *Lam.*	(*do.* 394). Atlantic Ocean.

Fam. Scalidae.

1380.	Scala [=Scalaria] turtonis (*Turton*).	(*British*, 406). South Coast.
90.	S. clathrus (*Linné*) [=communis].	(*do.* 407). Lancashire Coast. Jersey, Channel Islands.
1381.	S. trevelyana (*Leach*).	(*do.* 408). Shetland.
1172.	S. clathratula (*Adams*).	(*do.* 409). Helford River, Cornwall.

91.	S. pseudoscalaris, *Brocchia.*	Rockhampton, Queensland.
342.	S. pretiosa, *Lam.*	China.
1629.	Cioniscus albidus, *G. Adams* [=Aclis unica, *Mont.*].	(*British*, 413). Elie, Fife.

Section *TAENIOGLOSSA* (Radula with formula 2. 1. 1. 1. 2.).

Fam. Naticidae.

82.	Natica lineata, *Chem.*	North-east Australia.
83.	N. ala-papilionis, *Chem.*	Philippine Islands. Grand Cayman, West Indies.
84.	N. pellis-tigrina, *Chem.*	Swan River.
340.	N. alabaster.	Grand Cayman, W.I.
584.	N. marmorata.	Suez. New Hebrides.
585.	N. maculosa, *Lam.*	Suez.
589.	N. fulminea, *Linné.*	Algiers.
590.	N. canrena, *Linné.*	Bahamas.
341.	N. (Stigmaulax) sulcata, *Lam.*	West Indies.
1378.	N. (Lunatia) sordida, *Phil.*	(*British*, 381). Shetland.
583.	N. (L.) catena (*Da Costa*).	(*do.* 383). St. Andrews. Nairn. Falmouth.
338.	N. (L.) alderi, *Forbes:*	(*do.* 384). Deerness, Orkney. Nairn. Kilchatten Bay, Clyde. Falmouth.
1379.	N. (L.) montagui, *Forbes.*	(*do.* 385). Dogger Bank.
588.	N. (L.) melanostoma, *Sow.*	Suez.
337.	Neverita chemnitzii, *Reclus.*	
85.	N. didyma, *Bolten.*	N. Jackson, Sydney (Chal. Exped.). Pozzuoli, Italy. Suez. China.
86.	N. albumen, *Linné.*	Andaman Islands.
89.	Ampullina fiuctuata, *Sow.*	Philippine Islands.
336.	Ruma maura, *Lam.*	
586.	R. bifasciata, *Gray.*	New Hebrides.

88.	Mamma mamilla, *Linné*.	Philippine Islands.
87.	M. columnaris, *Reclus*.	do.
591.	Catinus perspectivus, *Say*.	Luzou.
1224.	C. neritoideus, *Linné*.	Java.
592.	C. malificum, *Mal*.	do.

Fam. Lamellariidae.

1169.	Lamellaria perspicua (*Linné*).	(*British*, 390). Helford River, Cornwall.
593.	Velutina laevigata (*Penn.*).	(*do.* 391). John o' Groats. St. Andrews.

Fam. Trichotropidae.

1183.	Trichotropis borealis, *Brod. and Sow.*, var. acuminata, *Jeff.*	(*British*, 481). Firth of Forth.

Fam. Xenophoridae.

594.	Xenophora australis, *Sow*.	Java.

Fam. Onustidae.

1222.	Onustus exutus, *Reeve*.	China.

Fam. Capulidae.

399.	Capulus hungaricus (*Linné*).	(*British*, 374). Deerness, Orkney. John o' Groats. Tenby, Wales. Torquay. Channel Islands.
394.	Crucibulum scutellatum, *Gray*.	American Coasts.
398.	C. rude, *Brod.*	do.
600.	Crepidula porcellana, *Linné*.	East London, South Africa.
1202.	C. fornicata, *Linné*.	Tristan da Cunha.
397.	C. (Crepipatella) aculeata, *Chem.*	
595.	Calyptræa chinensis (*Linné*).	(*British*, 375). Helford River, Cornwall.
596.	C. dillwinnii, *Gray*.	Grand Cayman, West Indies.
599.	C. calyptræformis, *Linné*.	Port Jackson, Sydney (Chal. Exped.).

Fam. Hipponycidae.

601. Hipponyx militaris, *Linné*. — Fanning Island.

Fam. Solariidae.

99. Solarium [=Architectonica] perspectivum, *Linné*. — Indian Ocean.
100. S. pictum, *Phil.* — Moluccas.

Fam. Homalogyridae.

1167. Homalogyra atomus (*Phil.*). — (*British*, 370). Carnoustie, Firth of Tay.

Fam. Littorinidae.

1148. Lacuna parva (*da Costa*) [=puteolus], var. lactea, *Jeff.* — (*British*, 326). Herm, Channel Islands.
1149. L. pallidula (*da Costa*). — (*do.* 327). Corrie, Arran. South Coast.
1147. L. (Medoria) crassior (*Mont.*). — (*do.* 324). Deerness, Orkney. Firth of Forth. Shellness.
611. L. (Epheria) divaricata, *Fabr.* — (*do.* 325). Deerness, Orkney. Corrie, Arran. Helford River and Porthcurnow, Cornwall. Whitby.
603. Littorina rudis (*Maton*). — (*do.* 330). Deerness, Orkney. St. Andrews. Granton, Forth. Troon, Clyde. Tenby, Wales. Torquay. Falmouth.
var. tenebrosa, *Mont.* — Loch Maddy, North Uist.
var. patula, *Thorpe.* — St. Andrews.
var. nigrolineata. — do.
602. L. littorea (*Linné*). — (*British*, 331). Carnoustie, Tay. Granton, Forth. Falmouth.
395. L. glabrata, *Phil.* — Grand Cayman, West Indies.
582. L. obesa, *Say.* — New Hebrides.
605. L. sieboldii, *Phil.*
608. L. malaccana, *Phil.* — Bombay.
1150. L. (Melaraphe) neritoides (*Linné*). — (*British*, 329). Lyme Regis.
169. L. (M.) scabra, *Linné.* — Philippine Islands.
607. L. (M.) undulata, *D'Orb.* — Colombo.

604.	L. (Neritoides) obtusata (*Linné*).	(*British*, 328). Deerness, Orkney. Granton, Forth. Cumbrae and Troon, Clyde. Falmouth. Tresco, S.I.
	var. ornata, *Jeff.*	Deerness, Orkney. Granton. Falmouth.
412.	Tectarius muricatus, *Linné.*	Florida.
609.	T. nodulosa, *Tors.*	St. Michael's Rock, Fernando-Noronha (Chal. Exped.). Grand Cayman, West Indies.

Fam. Cyclophoridae.

1601.	Opisthostoma grandispinosum, *G.-A.*	Borneo.
652.	Cyclophorus fruhstorferi, *Mlldff.*	Java.
661.	C. decarinata, *Mouss.*	do.
662.	C. courbeli, *Ancey.*	do.
663.	C. zollingeri, *Mouss.*	do.
691.	C. perdix, *Brod. and Sow.*	do.
699.	Cyclotus discoideus, *Sow.*	do.
732.	C. fasiatus, *Mtr.*	do.
747.	C. inca, *D'Orb.*	Mount Pichincha, Ecuador.
757.	Hybocystis rochebruni, *Mab.*	Java.
777.	Pupina succinacea, *Mlldff.*	do.
1546.	Leptopoma (Dermatocera) vitrea, *Less.*	New Ireland.

Fam. Cyclostomatidae.

612.	Cyclostoma [=Pomatias] elegans, *Müll.*	(*Brit. L.* and *F.-W.*, 175). Croydon. Verona, Italy.
613.	C. melitensis, *Sow.*	St. Paul's Bay, Malta.
614.	C. maculatum, *Studer*	Geneva.
615.	C. nonleti, *Drap.*	San Sebastian.
1225.	Cistula (Tudora) ferruginea, *Lam.*	Majorca.
432.	Choanopoma lima, *C. B. Adams.*	Grand Cayman, West Indies.
1226.	Tropidophora cuvieriana, *Petit.*	Madagascar.

Fam. Aciculidae.

616.	Acicula [=Acme] lineata (*Drap.*).	(*Brit. L.* and *F.-W.*, 176). Scarborough.

Fam. Truncatellidae.

618.	Truncatella truncata (*Mont.*) [=truncatula].	(*British*, 373). Weymouth.
433.	T. modesta, *C. B. Ards.*	

Fam. Rissoidae.

619.	Rissoa parva (*da Costa*).	(*British*, 332). Deerness, Orkney. Harris, Hebrides. Porthcurnow and Durgan, Cornwall. Herm, C.I. Portrush, Ireland.
	var. interrupta, *Adams.*	Harris, Hebrides. Porthcurnow, Cornwall. Portrush, Ireland.
1621.	R. inconspicua (*Ald.*).	(*British*, 333). West Coast of Ireland.
1151.	R. violacea, *Desm.*	(*do.* 335). Helford River, Cornwall.
1622.	R. guerini, *Recluz.* [=costulata].	(*do.* 336). Jersey, Channel Islands.
1152.	Alvania [=Rissoa] lactea (*Mich.*).	(*do.* 337). Guernsey, Channel Islands.
1153.	A. cancellata (*da Costa*).	(*do.* 338). Harris, Hebrides. Herm, C.I.
1154.	A. reticulata (*Mont.*).	(*do.* 339). Island of Harris, Hebrides.
1155.	A. punctura (*Mont.*).	(*do.* 341). Helford River and Porthcurnow, Cornwall.
1623.	A. subsoluta (*Aradas*) [=abyssicola].	(*do.* 343). Newhaven, Forth.
1624.	Manzonia [=Rissoa] zetlandica (*Mont.*).	(*do.* 344). Eda Sound, Stornoway.
1156.	M. costata (*J. Adams*).	(*do.* 345). Helford River and Porthcurnow, Cornwall. Harris, Hebrides.
620.	do. do.	Teneriffe (Chal. Exped.).
1157.	Zipora [=Rissoa] membranacea (*J. Adams*).	(*British*, 346). Corrie, Arran. Herm, Channel Islands.
1158.	Onoba [=Rissoa] striata (*J. Adams*).	(*do.* 347). Deerness, Orkney. Harris, Hebrides. Helford River, Cornwall.
1625.	Hyala [=Rissoa] vitrea (*Mont.*).	(*do.* 349). Southport.
1626.	Setia [=Rissoa] fulgida (*J. Adams*).	(*do.* 351). Channel Islands.
1159.	Cingula [=Rissoa] semistriata (*Mont.*).	(*do.* 353). Teignmouth. Helford River. Herm, C.I.

1160.	C. trifasciata, *J. Adams* [=cingulus].	(*British*, 354). Deerness, Orkney. Helford River. Tresco, S.I. Herm, C.I.
1161.	Galeodina [=Rissoa] carinata (*da Costa*) [=striatula].	(*do.* 355). Porthcurnow, Cornwall.
1162.	Barleeia rubra (*Mont.*).	(*do.* 356). Carnoustie, Tay. Tenby, Wales. Helford River, Cornwall.

Fam. Paludestrinidae.

622.	Paludestrina [=Hydrobia] stagnalis (*Baster*) [=ulvae].	(*British*, 359; *Brit. L.* and *F.-W.*, 152). St. Andrews. Colvend. Bantry. Cleveden. Helford River.
1339.	P. jenkinsi (*Smith*).	(*Brit. L.* and *F.-W.*, 151; *Perth.*, 76). Perthshire.
1163.	P. ventrosa (*Mont.*).	(*British*, 361; *Brit. L.* and *F.-W.*, 149). Cleveden.
625.	Bithynia tentaculata (*Linné*).	(*Brit. L.* and *F.-W.*, 158). Edinburgh. Cambridge. Somerset. Abbeville, Somme. Cologne, Rhine.
1340.	B. leachii (*Sheppard*).	(*do.* 159). Tuxford, Middlesex.
627.	B. bulimoides, *Oliv.*	Ismailia, Egypt. On Papyrus, in River Nile.

Fam. Assimineidae.

630.	Assiminea grayana, *Leach.*	(*British*, 357; *Brit. L.* and *F.-W.*, 174). St. Andrews. Greenwich.
1627.	Paludinella [=Assiminea] littorina (*della Chiaje*).	(*do.* 358). Weymouth.
631.	A. francesia, *Bens.*	Calcutta.

Fam. Skeneidae.

1166.	Skenea planorbis (*Fabr.*).	(*British*, 368). Deerness, Orkney. Crail. Helford River, Cornwall.
	var. hyalina, *Jeffreys.*	Portrush, Ireland.

Fam. Jeffreysiidae.

1164.	Jeffreysia opalina, *Jeff.*	(*British*, 363). Island of Cumbrae, Firth of Clyde.
1628.	J. diaphana (*Ald.*).	(*do.* 362). St. Peter's Port, Guernsey.

Fam. Adeorbidae.

1165.	Adeorbis subcarinatus (*Mont.*).	(*British*, 365). Helford River, Cornwall.

Fam. Viviparidae.

632.	Vivipara [=Paludina] vivipara (*Linné*).	(*Brit. L.* and *F.-W.*, 162). Cambridge. R. Trent. Abbeville, Somme. Cologne, Rhine.
1341.	V. contecta (*Millet*).	(*do.* 164). Cambridge.
633.	V. bengalensis, *Lam.*	Calcutta.
634.	V. richthofeni, *Mndff.*	Java.

Fam. Valvatidae.

635.	Valvata piscinalis (*Müll.*).	(*Brit. L.* and *F.-W.*, 167; *Perth.*, 77). Perthshire. Marple, Cheshire. Cologne, Rhine.
1342.	V. cristata, *Müll.*	(*do.* 173; *do.* 78). Perthshire. R. Thames.

Fam. Ampullariidae.

626.	Ampullaria [=Marisa] cornu-arietes, *Linné*).	Brazil.
636.	A. globosa, *Sow.*	Pulicat.
637.	A. layardi, *Reeve* [=A. virens, *Lam.*, var. layardi].	Colombo.
638.	A. cubensis, *Reeve.*	Cuba.
639.	A. polita, *Desh.*	Java.
640.	A. javanica, *Reeve.*	do.
641.	Lanistes bolteniana, *Chem.*	River Nile.

Fam. Cerithiidae.

166.	Cerithium nodulosum, *Brug.*	Suez. East Africa. Andaman Islands.
167.	C. citrinum, *Sow.*	Philippine Islands.
642.	C. rugosum, *Wood.*	Bombay. New Hebrides. Gardner's Island.
643.	C. obeliscus, *Brug.*	Suez. New Hebrides. Yenoshima, Japan.

644.	C. tuberculatum, *Linné.*	Fiji. Torres Straits.
646.	C. vulgatum, *Brug.*	Mediterranean.
647.	C. mamillata.	Ismailia, Egypt.
648.	C. cœruleum, *Sow.*	Suez.
650.	C. echinatum, *Lam.*	Sawarrowa Island.
655.	C. moniliferum, *Dufr.*	Suez.
657.	C. lemniscatum, *Quoy.*	New Hebrides.
658.	C. rupestre, *Risso*, var. minor, *B.D.D.*	do.
659.	C. gracile, *Phil.*	do.
164.	Vertagus vulgaris, *Schum.*	Port Essington. Yenoshima, Japan.
165.	V. asperum, *Linné.*	Mauritius. New Hebrides.
649.	V. pharos, *Hinds.*	St. Mary's Island.
666.	V. pictus, *Wood.*	Grand Cayman, West Indies.
163.	V. fasciatus, *Brug.*	Mozambique.
651.	Bittium reticulatum (*da Costa*).	(*British*, 397). Tenby, Wales. Torquay. Falmouth. Herm, C.I. Portrush, Ireland.
654.	B. perparvulum, *W.*	Flinder's Passage (Chal. Exped.).
1170.	Triforis perversa (*Linné*).	(*British*, 398). Corrie, Arran. Herm, C.I. Portrush, Ireland.
653.	T. granulatus, *Adams and Reeve.*	Suez, Bushire, Persian Gulf.
168.	Telescopium fuscum, *Chem.*	India. North Australia.
669.	T. lœve, *Q. and G.*	India.
645.	Tympanotonos fluviatilis, *Pot. and Mich.*	Madras. Bushire, Persian Gulf.
676.	T. fuscatus, *Linné.*	Gambia.
677.	Pyrazus palustris, *Mont.*	India.
672.	Planaxis savignyi, *Desh.*	Suez. Bombay.
396.	P. semisulcata, *Lam.*	
673.	P. sulcata, *Born.*	Canton Island.
674.	P. pedicularis, *Lam.*	Grand Cayman, West Indies.
1171.	Cerithiopsis tubercularis (*Mont.*).	(*British*, 400). Corrie, Arran.

Fam. Modulidae.

678.	Modulus tectum, *Gmel.*	New Hebrides.

Fam. Melaniidae.

687.	Melania acutecarinata, *v. d. Br.*	Java.
688.	M. tournennsis, *Soul.*	do.
689.	M. devians, *Brol.*	do.
690.	M. crenulata, *Desh.*	do.
887.	Gyrotoma (Megara) harpa, *Lea.*	Alabama.
681.	Vibex tuberculosa, *Rang.*	Ismailia, Egypt.
686.	V. aurita, *Müll.*	West Africa.
623.	Melanopsis amnonis, *Tristram.*	Rabboth Amnon, Palestine.
624.	M. eremita.	Near the Dead Sea, Palestine.
680.	M. (Canthidomus) costata, *Fér.*	Sea of Galilee, Palestine.
683.	Melanoides obeliscus, *Lea.*	Lake Pelow.
682.	Faunus ater (*Linné*).	Ceylon.

Fam. Pleuroceridae.

693.	Io fluviatilis, *Say.*	North America.

Fam. Turritellidae.

694.	Turritella communis, *Lam.*	(*British*, 480). St. Andrews. Troon, Clyde. Falmouth, Cornwall.
	var. nivea, *Jeff.*	St. Andrews.
170.	T. terebra, *Linné.*	Philippine Islands.
171.	T. attenuata, *Reeve.*	do.
174.	T. bicingulata, *Lam.*	Cape Verd Islands.
173.	T. (Haustata) columnalis, *Keiner.*	Ceylon.
696.	Torcula carinifer, *Lam.*	East London, South Africa.
172.	Zaria duplicata, *Linné.*	
695.	Z. triplicata, *Studer.*	Australia.

Fam. Coecidae.

1181.	Coecum imperforatum (*G. Adams*) [=trachea].	(*British*, 478). Helford River, Cornwall.
1182.	C. glabrum (*Mont.*).	(*do.* 479). do. do.

Fam. Vermetidae.

698.	Vermetus conicus, *Dill.*	

Fam. Strombidae.

121.	Strombus lentiginosus, *Linné.*	Suez. Philippine Islands.
122.	S. bituberculatus, *Lam.*	Island of Granada. Grand Cayman, West Indies.
123.	S. lamarckii, *Gray.*	Philippine Islands.
359.	S. mauritianus, *Lam.*	Mauritius.
364.	S. gigas, *Linné.*	Grand Cayman, West Indies.
365.	S. pugilis, *Linné.*	do. do..
369.	S. pacificus, *Swain.*	Australia.
370.	S. isabella, *Lam.*	Singapore.
218.	S. (Gallinula) minimus, *Linné.*	New Hebrides.
368.	S. (G.) variabilis, *Swain.*	North Queensland.
371.	S. (G.) sibbaldii, *Sow.*	New Hebrides.
124.	S. (G.) succinctus, *Linné.*	Philippine Islands.
367.	S. (G.) vittatus, *Linné.*	do.
702.	S. (G.) deformis, Gray.	Suez.
128.	S. (G.) canarium, *Linné.*	Borneo.
129.	S. (G.) floridus, *Lam.*	Philippine Islands. Fiji Islands. Sawarrowa Island. New Hebrides. Suez.
126.	S. (Canarium) gibberulus, *Linné.*	Suez. Andaman Islands.
700.	S. (C.) urceus, *Linné.*	Andaman Islands. Yenoshima, Japan. Jamaica, West Indies.
125.	S. (C.) luhuanus, *Linné.*	Port Essington.
703.	S. (C.) fasciatus, *Born.*	Suez.
372.	S. (Monodactylus) tricornis, *Mart.*	Red Sea.

127.	S. (M.) auris-dianæ, *Linné*.	Philippine Islands. Australia. Mauritius.
130.	Pterocera truncata, *Lam*. [=brionia].	Red Sea. South Africa.
132.	P. chiragra, *Linné*.	Indian Ocean.
131.	P. (Heptadactylus) lambis, *Linné*.	North Australia.
704.	Terebellum subulatum, *Chem*.	New Hebrides.
373.	Rostellaria curtus, *Sow*.	Suez. New Zealand.
705.	R. delicatula, *Nevill*.	Karachi, Persian Gulf.

Fam. Chenopodidae [=Aporrhaidae].

707.	Chenopus [=Aporrhais] pes-pelicani (*Linné*).	(*British*, 485). North Berwick, Forth. Bournemouth. Falmouth, Cornwall. Pozzuoli and Syracuse, Italy. Rockhampton, Queensland.
1579.	A. pes-carbonis, *Brogn*. [=serresianus (*Mich*.)], var. macandreæ, *Jeffreys*.	(*do*. 486). Shetland Islands.

Fam. Struthiolariidae.

374.	Struthiolaria papulosa, *Martyn*	New Zealand.
708.	S. mirabilis, *Smith*.	Royal S. Kergualen (Chal. Exped.).
709.	S. scutulata, *Martyn*.	Port Jackson, Sydney (Chal. Exped.).

Fam. Cypræidae.

136.	Cypræa carneola, *Linné*.	Suez. Philippine Islands. Grand Cayman, West Indies.
137.	C. talpa, *Linné*.	Ceylon.
138.	C. argus, *Linné*.	do.
141.	C. isabella, *Linné*.	Suez. Pacific Islands.
142.	C. cruenta, *Gmel*.	Indian Ocean.
158.	C. asellus, *Linné*.	Indian Ocean. Suez.
159.	C. hirundo, *Linné*.	Mauritius. Andaman Islands. New Hebrides.
160.	C. lutea, *Gron*.	Philippine Islands.

362.	C. testudinaria, *Linné.*	New Hebrides.
376.	C. exanthema, *Linné.*	Grand Cayman, W.I. Florida.
382.	C. cervinetta, *Kien.*	California. Panama.
388.	C. tabescens, *Dil.*	Mauritius.
389.	C. quadrimaculata, *Gray.*	Singapore.
392.	C. reticulata, *Martyn.*	North West Australia. Mauritius.
393.	C. cinerea, *Gmel.*	Grand Cayman, W.I.
710.	C. lurida, *Linné.*	Pozzuoli, Italy. St. Paul's Bay, Malta.
1132.	C. fimbriata, *Gmel.*	Suez.
1133.	C. acicularis, *Gmel.*	Grand Cayman, W.I.
1134.	C. staphylæa, *Linné.*	New Hebrides.
1136.	C. pulicaria, *Reeve.*	South Australia. Tasmania.
1139.	C. cervus, *Linné.*	West Indies.
1313.	C. thersites, *Gask.*	North West Australia.
1314.	C. ventriculus, *Lam.*	Australia.
154.	C. errones, *Linné.*	Suez. Sandwich Islands.
134.	C. (Aricia) mauritiana, *Linné.*	Indian and Pacific Oceans.
139.	C. (A.) arabica, *Linné.*	Mauritius.
1128.	C. (A.) arabicula, *Lam.*	Mazathan, West Mexico.
148.	C. (A.) moneta, *Linné.*	Aneityum, New Hebrides. [The "money cowrie," used as money in the Pacific Islands.]
363.	C. (A.) mus, *Linné.*	West Indies.
150.	C. (A.) annulus, *Linné.*	Suez. Fiji Islands. Aneityum, New Hebrides.
378.	C. (A.) caput-serpentis, *Linné.*	do. do. do. do.
1126.	C. (A.) punctulata, *Gray.*	Panama.
377.	C. (A.) histrio, *Linné.*	Indian Ocean. North West Australia.
135.	C. (Luponia) vitellus, *Linné.*	Indian Ocean. Ceylon.
143.	C. (L.) gangrenosa, *Solander.*	Mozambique.
144.	C. (L.) stolida, *Linné.*	Ceylon.

146.	C. (L.) ocellata, *Kien.*	Mauritius.
147.	C. (L.) helvola, *Linné.*	Ceylon. Sydney Island.
151.	C. (L.) onyx, *Linné.*	California.
152.	C. (L.) erosa, *Linné.*	Suez. Mauritius. New Hebrides.
155.	C. (L.) cribraria, *Linné.*	Singapore. New Hebrides.
157.	C. (L.) clandestina, *Linné.*	Ceylon.
161.	C. (L.) picta, *Gray.*	West Africa.
384.	C. (L.) camelopardalis, *Perry.*	Red Sea.
385.	C. (L.) lamarckii (*Gray*).	Andaman Islands.
386.	C. (L.) spurca, *Linné.*	Algiers. St. Paul's Bay, Malta. Grand Cayman, W.I.
387.	C. (L.) miliaris (*Linné*).	Philippine Islands.
598.	C. (L.) aurantium, *Martyn.*	New Caledonia.
391.	C. (L.) caurica (*Linné*).	Indian Ocean.
581.	C. (L.) mappa, *Linné.*	New Caledonia.
1124.	C. (L.) angustata, *Gray.*	Australia.
1138.	C. (L.) poraria, *Linné.*	Sydney.
1140.	C. (L.) pyrum, *Gmel.*	Mediterranean.
1386.	C. (L.) spadicea, *Swains.*	California.
133.	C. (L.) tigris, *Linné.*	Suez. Mauritius. Indian and Pacific Oceans.
375.	C. (L.) pantherina, *Soland.*	Suez. Red Sea.
140.	C. (L.) lynx, *Linné.*	Mozambique. Aneityum, New Hebrides.
145.	C. (L.) undata, *Lam.*	Philippine Islands.
156.	C. (L.) ziczac, *Linné.*	Mozambique.
1127.	C. (L.) turdus, *Linné.*	Suez.
37.	C. (Trivia) europæa (*Mont.*).	(*British*, 377). Deerness, Orkney. Carnoustie, Tay. Cumbrae, Clyde. Hebrides. Falmouth, Cornwall. Tresco, S.I. Herm, C.I.
149.	C. (T.) nucleus, *Linné.*	Borneo. Fanning Island.
380.	C. (T.) pediculus, *Linné.*	Grand Cayman, W.I.
383.	C. (T.) suffusa, *Gray.*	do.

390.	C. (T.) cicercula, *Linné.*	New Caledonia.
610.	C. (T.) pustulata, *Lam.*	Gulf of California.
1129.	C. (T.) nivea, *Gray.*	West Indies. Florida.
1130.	C. (T.) quadripunctata, *Gray.*	Australia.
1131.	C. (T.) scabriuscula, *Gray.*	Fanning Island.
162.	Ovula ovum, *Linné.*	New Guinea.
711.	Cyphoma gibbosa, *Linné.*	Grand Cayman, W.I.
1227.	Birostra volva, *Linné.*	China. Australia.
1168.	Erato [=Marginella] laevis (*Donovan*).	(*British*, 379). Herm, Channel Islands.
317.	E. maugeriæ, *Gray.*	

Fam. Doliidae.

77.	Dolium maculatum, *Lam.*	Andaman Islands.
78.	D. zonatum, *Green.*	China.
79.	D. perdix, *Linné.*	Society Islands. Grand Cayman, W.I.
332.	D. variegatum, *Lam.*	New Holland.
333.	D. fasciatum, *Lam.*	Philippine Islands.
334.	D. chinense, *Desh.*	China. Grand Cayman, W.I.
80.	Malea pomum, *Linné.*	Society Islands. Suez. Yenoshima, Japan.
81.	Pyrula ficoides, *Lam.*	Moluccas Islands. India.
263.	P. vespertilio, *Lam.*	Indian Ocean.
713.	P. laevigata, *Linné.*	
714.	P. reticulata, *Linné.*	Japan. China.

Fam. Cassididae.

72.	Cassis flammea, *Brug.*	Jamaica and Grand Cayman, W.I.
326.	C. tuberosa, *Lam.*	Florida. Bahamas.
74.	Semicassis japonica, *Reeve.*	Japan.
75.	S. pila, *Reeve.*	Island of Luzon.
329.	S. canaliculatus, *Brug.*	Algiers.
335.	S. sulcosa, *Born.*	Suez.

73.	S. (Phalium) areola, *Brug.*	Philippine Islands.
76.	S. (P.) glauca, *Lam.*	do.
1228.	S. (P.) undatus, *Martyn.*	do.
717.	S. (Casmaria) vibex, *Linné.*	Australia. Mauritius.
715.	S. (Cassidea) testiculus, *Lam.*	Grand Cayman, W.I.
71.	S. (C.) rufus, *Linné.*	Mauritius. Island of Anna, Moluccas.
721.	Oniscia oniscus, *Linné.*	Grand Cayman, W.I.

Fam. Tritonidae.

273.	Triton australe, *Lam.*	Mediterranean.
18.	T. variegatum, *Lam.*	Pacific Islands. [The "Conch" Shell, used as a trumpet by the Pacific Islanders.]
215.	T. spinosum, *Rouault.*	
276.	T. flavus.	
727.	T. pilearis, *Lam.*	Algiers. West Indies.
19.	T. (Simpulum) rubeculum, *Linné.*	Philippine Islands. New Hebrides.
724.	T. (S.) gemmatus, *Reeve.*	Mauritius.
271.	T. (Cabestana) doliarium, *Linné.*	Cape of Good Hope.
272.	T. (Cymatium) lotorium, *Linné.*	
728.	T. (C.) femoralis, *Linné.*	West Indies.
20.	T. (Gutturnium) tripus, *Lam.*	Suez. Ceylon. China.
722.	T. (G.) sarcostoma, *Reeve.*	
274.	T. (Epidromus) quoyi, *Reeve.*	Algiers. Australia.
725.	T. (E.) tortuosus, *Reeve.*	New Hebrides.
731.	T. (E.) distortum, *Schub. and Wag.*	Philippine Islands.
22.	Distorsio [=Persona] anus, *Lam.*	Society Islands. New Hebrides.
277.	D. ridens, *Reeve.*	
23.	Bursa [=Ranella] rana, *Linné.*	Ceylon.
735.	B. crumena, *Lam.*	Bay of Manilla.
24.	B. granifera, *Lam.*	North Australia.

734.	B. foliata, *Brod.*	Philippine Islands.
736.	B. spinosa, *Lam.*	China. Ceylon. Mauritius.
1229.	B. (Apollon) clathrata, *Lam.*	
275.	B. (A.) vexillam, *Sow.*	Tristan da Cunha.
733.	B. (A.) olivator, *Meusch.*	Madras.

Fam. Atlantidae.

737.	Atlanta peronii, *Lesueur and Blainv.*	Pacific Ocean.

Fam. Eulimidae.

1179.	Eulima polita (*Linné*).	(*British*, 464). Herm, Channel Islands.
1180.	E. (Leiostraca) bilineata (*Ald.*).	(*do.* 476). Deerness, Orkney. Porthcurnow, Cornwall.
1637.	Stilifer stylifer (*Turt.*) [=turtoni].	(*do.* 477). Newhaven, Firth of Forth.

Fam. Pyramidellidae.

1173.	Odostomia lukisi, *Jeff.*	(*British*, 422). Helford River, Cornwall.
1630.	O. unidentata, *Forbes and Hanley.*	(*do.* 427). Elie, Fife.
1174.	O. turrita, *Hanley.*	(*do.* 428). Helford River, Cornwall.
1631.	O. plicata (*Mont.*).	(*do.* 429). Elie, Fife.
1632.	Jordanula [=Odostomia] nivosa (*Mont.*).	(*do.* 430). Cornwall.
1633.	Brachystomia [=Odostomia] albella, *Lovén.*	(*do.* 433). Bullslanger Bay, Pembrokshire.
1175.	B. [=Odostomia] rissoides (*Hanley*).	(*do.* 434). Helford River, Cornwall. Teignmouth.
1634.	B. ambigua (*Maton and Rackett*) [=pallida].	(*do.* 435). Newhaven, Fife.
1635.	Pyrgulina [=Odostomia] indistincta (*Mont.*).	(*do.* 447). do. do.
1176.	P. [=Odostomia] interstincta (*Mont.*).	(*do.* 448). Porthcurnow, Cornwall.
1636.	Spiralinella [=Odostomia] spiralis (*Mont.*).	(*do.* 451). Newhaven, Fife.
1177.	Turbonilla [=Odostomia] lactea (*Linné*).	(*do.* 455). Margate. Helford River. Herm, C.I.
1178.	Eulimella [=Odostomia] nitidissima (*Mont.*).	(*do.* 463). Porthcurnow, Cornwall.
343.	Obeliscus dolabratus, *Linné.*	Grand Cayman

Section *RACHIGLOSSA* (Radula with marginal teeth. Teeth strongly cusped).

Fam. Muricidae.

3.	Murex brevispina, *Lam.*	Suez. Algiers. Ceylon. Australia.
4.	M. tenuispina, *Lam.*	Philippine Islands.
5.	M. macgillivrayi, *Dohrn.*	Lizara Island.
262.	M. palma-rosae, *Lam.*	Indian Ocean. Ceylon.
511.	M. regius, *Wood.*	Panama.
740.	M. martinianus, *Reeve.*	
6.	M. (Haustellum) haustellum, *Linné.*	Ceylon. Mauritius.
742.	M. (Rhinocantha) cornutus, *Linné.*	West Africa.
753.	M. (R.) brandaris, *Linné.*	Malaga, Spain. Algiers.
744.	M. (Chicoreus) cervicornis, *Lam.*	
750.	M. (C.) corrugatus, *Low.*	
8.	M. (C.) adustus, *Lam.*	New Hebrides. Japan.
751.	M. (C.) capucinus, *Chem.*	Suez.
7.	M. (C.) ramosus, *Linné.*	Suez. Mauritius.
726.	M. (Pteronotus) uncinarius, *Lam.*	East London, South Africa.
741.	M. (Phyllonotus) bicolor, *Valenc.*	Lower California.
745.	M. (P.) saxatilis, *Linné.*	West Africa. Indian Ocean.
743.	M. (P.) truncatulus, *Linné.*	Syracuse. Suez. Port Said.
9.	M. (P.) radix, *Gmel.*	Pacific Islands.
748.	Ocinebra [=Murex] erinacea (*Linné*).	(*British*, 511). St. Andrews. Ayr. North Berwick. Tenby, Wales. Falmouth and Helford River.
749.	O. corallina, *Scacchi* [=aciculatus].	(*do.* 512). Herm, Channel Islands.
	var. bandia, *Jeff.*	do. do.
32.	Purpura persica, *Lam.*	New Hebrides.
1125.	P. patula, *Linné.*	Algiers. Philippine Islands.
33.	P. bufo, *Lam.*	Madras. China.
34.	P. flindersi, *A. Adams and Angus.*	South Australia.

35.	P. ostrina, *Gould.*	Labrador.
765.	P. (Drupa) livida, *Rve.*	Bombay.
282.	P. (Thalessa) bitubercularis, *Lam.*	Zanzibar.
762.	P. (T.) hippocastanum, *Linné.*	Algiers.
764.	P. (Polytropa) lapillus (*Linné*).	(*British*, 518). Deerness, Orkney. St. Andrews. Granton and Joppa, Forth. Luce Bay. Falmouth.
	var. imbricata, *Lam.*	Granton, Forth.
	banded var.	Newquay, North Cornwall.
523.	Concholepas peruviana, *Lam.*	Peru.
281.	Cuma tectum, *Wood.*	Central America.
1382.	Trophon muricatus (*Mont.*).	(*British*, 515). Shetland.
1187.	T. clathratus (*Linné*), var. truncata, *Ström.* [=T. truncatus].	(*do.* 516). Deerness, Orkney. Granton, Forth.
36.	Rapana bulbosa, *Solander.*	Chinese Seas.
760.	Ricinula ricinus, *Linné.*	Sawarrowa Island.
755.	R. arachnoides, *Lam.*	Suez.
758.	R. datteratum, *Lam.*	Palmerston Island.
759.	R. morum, *Lam.*	Canton Island.
756.	R. (Pentadactylus) horridus, *Lam.*	Sydney Island. Yenoshima, Japan.
761.	R. (Sistrum) fiscellum, *Chem.*	Suez. Bombay.
763.	R. (S.) tuberculatus, *Blainv.*	New Hebrides.
767.	R. (S.) concatenata (*Lam.*).	Suez.
768.	R. (S.) margaritocolus, *Brod.*	New Hebrides.
816.	R. (S.) muricata, *Reeve.*	Andaman Islands.

Fam. Coralliophilidae.

773.	Rapa papyracea, *Linné.*	Andaman Islands.
769.	Coralliophila madreporana, *Reeve.*	New Hebrides.
597.	Magilus [=Campulotus] antiquus, *Montfort.*	Red Sea. [The Coral-boring Shell.]

Fam. Columbellidae.

318.	Columbella mercatoria, *Linné*.	Grand Cayman, W.I. [Used as money in the West Indies.]
266.	C. lœvigata, *Linné*.	West Indies.
320.	C. rustica, *Linné*.	Pozzuoli. Tyre. Suez. Algiers.
617.	C. versicolor, *Sow*.	New Hebrides. Australia.
775.	C. fulgurans, *Lam*.	Pacific Ocean.
780.	C. tyleri, *Gray*.	New Hebrides.
319.	C. (Nitidella) nitida, *Lam*.	West Indies.
774.	C. (N.) dichroa, *Sow*.	
781.	C. (Mitrella) ligula, *Duclos*.	New Hebrides.
784.	Arachis terpsichose, *Leathes*.	Colombo.
321.	Pyrene ovulata, *Lam*.	
268.	Amycla (Astyris) marquesa, *Lam*.	
12.	Engina pulchra, *Reeve*.	Philippine Islands.
13.	E. (Pusiostoma) mendicaria, *Lam*.	Suez. Madagascar.
776.	E. zonata, *Reeve*.	Andaman Islands.
1230.	E. rutila, *Reeve*.	Fiji Islands.

Fam. Nassidae.

27.	Nassa canaliculata, *Lam*.	Philippine Islands (Chal. Exped.).
789.	N. pulla, *Linné*.	Aden.
790.	N. coronata, *Brug*.	Suez.
804.	N. mutabilis (*Linné*).	Pozzuoli, Italy. Suez. Algiers.
814.	N. pyramidalis, *Adams*.	East London, South Africa.
28.	N. arcularia, *Lam*.	Philippine Islands. New Hebrides.
801.	N. (Niotha) paupirata, *Linné*.	Port Jackson, Sydney (Chal. Exped.).
803.	N. (N.) marginulata, *Linné*.	Suez.
796.	N. (N.) albescens, *Dunker*.	New Hebrides.
787.	N. (Phrontis) fasciata, *Chem*.	Australia.

791.	N. (Arcularia) gibbosuta, *Linné.*	Suez.
793.	N. (A.) granifer, *Kiener.*	New Hebrides.
794.	N. (A.) globosa, *Quoy and Gaim.*	Andaman Islands.
805.	N. (A.) callispira, *A. Ads.*	Suez.
807.	N. (A.) thersites, *Lam.*	Philippine Islands.
278.	N. (Zeuxis) crenulata, *Brug.*	Andaman Islands.
808.	N. (Z.) tænia, *Gmel.*	do.
786.	N. (Z.) incrassata (*Ström.*).	(*British*, 522). Deerness, Orkney. Corrie, Arran. Carnoustie. Forth. Torquay. Falmouth, Cornwall.
1383.	N. (Hima) pygmæa (*Lam.*).	(*do.* 523). South Coast of Cornwall.
797.	N. (H.) geniculata, *A. Ads.*	New Hebrides.
785.	N. (Tritia) reticulata (*Linné*).	(*British*, 521). Troon, Clyde. Portincross. Falmouth and Helford River, Cornwall.
26.	Bullia rhodostoma, *Gray.*	Cape of Good Hope.
738.	B. digitalis, *Meusch.*	East London, South Africa.
25.	Pseudostrombus (Leiodomus) vittatus, *Linné.*	Ceylon.
815.	P. (L.) tranquebaricus, *Bolt.*	Bombay.
279.	P. belangeri, *Kien.*	South Africa.
280.	Neritula [=Cyclops =Cyclonassa] neritea, *Linné.*	Mediterranean.
29.	Cominella porcata, *Gmel.*	Cape of Good Hope.
286.	C. livida, *Reeve.*	Zanzibar.
719.	Desmoulea retusa, *Gray.*	East London, South Africa.

Fam. Buccinidae.

818.	Buccinum undatum, *Linné.*	(*British*, 492). St. Andrews. Firth of Forth. Falmouth.
	var. pelagica, *King.*	Nairn.
	mons. accuminatum, *Brod.*	Kent.
	mons. carinatum, *Turt.*	St. Andrews.
	mons. sinistrorsum.	do.

770.	B. undosum, *Linné.*	New Hebrides.
819.	B. sericatum, *Hancock.*	Davis Straits.
832.	Neptunea [=Fusus] antiqua (*Linné*).	(*British*, 498). Nairn. St. Andrews. Firth of Forth.
1184.	Volutopsis [=Fusus] norvegicus (*Chem.*).	(*do.* 499). Dogger Bank. (Identified by J. Gwyn Jeffreys.)
1185.	Beringius [=Fusus] turtoni (*Bean*).	(*do.* 500). do. do.
833.	Tritonofusus [=Fusus] gracilis (*da Costa*).	(*do.* 502). St. Andrews. Penzance. Davis Straits.
823.	Pisania pusio, *Linné.*	West Indies.
825.	P. (Pollia) rubiginosa, *Rve.*	Suez.
30.	Eburna spirata, *Lam.*	Ceylon.
31.	E. zeylandica, *Brug.*	do.
827.	E. canaliculata, *Schum.*	Japan.
896.	Donovania [=Lachesis] minima (*Mont.*).	(*British*, 496). Helford River, Cornwall. Herm, Channel Islands.
895.	D. mamillata, *Risso.*	

Fam. Turbinellidae.

59.	Turbinella pyrum, *Linné.*	Ceylon.
311.	T. scolymus, *Lam.*	Bahamas.
309.	Tudicla spirilis, *Linné.*	Indian Ocean.
310.	T. retusum, *Linné.*	Ceylon.
1238.	Fulgur [=Busycon] perversum, *Linné.*	Florida.
60.	Vasum [=Scolymus =Cynodonta] cornigerus, *Lam.*	Suez. Moluccas. West Indies.
1233.	V. rhinoceros, *Gmel.*	Zanzibar.
264.	Melongena [=Cassidulus] melongena, *Linné.*	West Indies.
1239.	M. corona, *Gmel.*	Florida.
2.	M. (Volema) pugilinus, *Born.*	Ceylon.
265.	M. (V.) paradisica, *Reeve.*	Suez. Red Sea.
518.	M. (Megalatractus) proboscidifera, *Lam.*	Torres Straits. North Australia. [The largest univalve shell.]

Fam. Fasciolariidae.

55.	Fasciolaria trapesium, *Linné.*	Philippine Islands.
56.	F. filamentosa, *Chem.*	Andaman Islands.
307.	F. tulipa, *Linné.*	West Indies. Florida.
1186.	Buccinofusus [=Fusus] berniciensis (*King*).	(*British*, 509). Dogger Bank. (Identified by J. Gwyn Jeffreys.)
829.	Fusus colus, *Linné.*	Ceylon.
830.	F. longicauda, *Bory.*	do.
831.	F. strigatus, *Phil.*	Suez.
10.	Cantharus tranquebaricus, *Müll.*	East Africa.
11.	C. (tritonidea) rubiginosa, *Reeve.*	Red Sea.
58.	Latirus gibbulus, *Gmel.*	Australia.
308.	L. filosa, *Schub. and Wag.*	Indian Ocean.
836.	L. infundibulum, *Lam.*	Barbadoes.
837.	L. lyrata, *Gmel.*	
1231.	L. craticulatus, *Linné.*	Red Sea.
57.	L. (Plicatella) polygonus, *Linné.*	New Hebrides. Society Islands.
834.	Peristernia pulchella, *Reeve.*	Andaman Islands.
840.	Leucozonia cingulata, *Lam.*	Panama.
1232.	Lotorium (Lagena) clandestinum, *Chem.*	Zebu, Philippine Islands.

Fam. Mitridae.

68.	Mitra episcopalis, *Lam.*	Philippine Islands.
69.	M. pontificalis, *Lam.*	do.
70.	M. crebrilirata, *Reeve.*	Ceylon.
291.	M. striatula, *Lam.*	Grand Cayman, W.I.
505.	M. granulosa, *Lam.*	do.
817.	M. discoloria, *Reeve.*	Andaman Islands.
841.	M. vulpecula, *Lam.*	Philippine Islands. Singapore.
517.	M. (Nebularia) granata, *Reeve.*	Grand Cayman, W.I.

849.	M. (Scabricola) granatina, *Lam.*	New Hebrides.
846.	M. (Chrysame) procissa, *Reeve.*	do.
847.	M. (C.) tiarella, *Sow.*	do.
848.	M. (C.) tabanula, *Lam.*	do.
269.	Volumitra cornicula, *Lam.*	Suez.
835.	V. ebenus, *Lam.*	New Hebrides.
850.	Strigatella virgata, *Reeve.*	do.
851.	S. auriculoides, *Reeve.*	do.
842.	Turricula (costellaria) semifasciata, *Lam.*	Yenoshima, Japan. New Hebrides.
852.	T. (C.) arenosa, *Lam.*	New Hebrides.
853.	T. (C.) nodilyrata, *A. Ads.*	do.
854.	T. (C.) pacifica, *Lam.*	do.

Fam. Volutidae.

314.	Voluta musica, *Linné.*	West Indies.
316.	V. hebræa, *Linné.*	West Africa.
66.	V. imperialis, *Solander.*	Philippine Islands.
313.	Harpula vexillum, *Chem.*	Ceylon.
65.	Fulguraria fulminata, *Lam.*	Japan.
1206.	Cymbium olla, *Linné.*	Malaga, Spain (originally a native of West Africa).
61.	C. ethiopium, *Linné.*	Indian Ocean.
62.	Melo broderipii, *Gray.*	Manilla.
63.	M. indica, *Gmel.*	Indian Ocean.
325.	M. diadema, *Lam.*	New Guinea.
312.	Cymbiola magnifica, *Chem.*	Australia.
381.	Scaphella [=Voluta] elliotti, *Sow.*	North West Australia.
1234.	S. undulata, *Lam.*	Australia.
64.	Aulica vespertilio, *Linné.*	Amboina.
327.	A. scapha, *Gmel.*	Singapore.

Fam. Marginellidae.

67.	Marginella guttata, *Dillwyn.*	Jamaica and Grand Cayman, West Indies.
857.	M. avena, *Val.,* var. beyerleana.	West Indies.
858.	M. piperata, *Hinds.*	East London, West Africa.
859.	M. reevii, *Marrat.*	do. do.
860.	M. prunum, *Gmel.*	Panama.
862.	M. interrupta, *Lam.*	Barbadoes.
856.	M. (Prunum) conoidalis, *Kien.*	West Indies.
861.	M. (P.) monilis, *Lam.*	Suez.

Fam. Harpidae.

322.	Harpa imperialis, *Lam.* [=costata, *Linné*].	Mauritius.
	var. multicostata, *Sow.*	do.
54.	H. ventricosa, *Lam.* [=major, *Bolten*].	Suez. Mauritius.
	var. intermedia, *Ms.*	Mauritius.
53.	H. conoidalis, *Lam.*	Ceylon.
324.	H. articularis, *Lam.* [=davidis, *Bolten*].	Mauritius.
323.	H. nobilis, *Rumph.*	New Caledonia. Philippine Islands.
771.	H. crenata, *Swain.*	Acapulca, Central America.
772.	H. doris, *Bolten* [=rosea, *Lam.*].	Cape Verd Islands.
863.	H. minor, *Martyn.*	Ceylon. Society Islands.
	var. oblonga, *Schum.*	Philippines. Ambogna.
	var. crassa, *Mörch.*	Philippines.
1417.	H. cancellata, *Chem.*	New Caledonia.

Fam. Olividae.

290.	Oliva inflata, *Lam.*	Suez. Aden. Fiji. Andaman Islands.
39.	O. tricolor, *Lam.*	Mauritius.
40.	O. elegans, *Lam.*	Suez. Fiji. Andaman Islands.

42. O. textilina, *Lam.*	Philippine Islands.
43. O. episcopalis, *Lam.*	Mozambique.
44. O. sanguinolenta, *Lam.*	Philippine Islands.
46. O. leucostoma, *Duclos.*	Moluccas.
288. O. maura, *Lam.* [=funebralis].	Suez. Ceylon. Philippine Islands.
292. O. cruenta, *Dillwyn.*	
295. O. subulata, *Lam.*	South Australia.
298. O. reticularis, *Lam.*	Florida.
47. O. (Stephona) jaspidea, *Duclos.*	Tahiti.
48. O. (S.) peruviana, *Lam.*	California.
37. O. (Porphyria), porphyria, *Linné.*	Panama.
38. O. (P.) ponderosa, *Duclos.*	Mauritius.
287. O. (P.) irisans, *Lam.*, var. cryptospira, *Ford.*	Philippine Islands.
289. O. (Ispidula) ispidula, *Linné.*	do.
41. O. (I.) erythrostoma, *Lam.*	Indian Ocean. New Hebrides.
865. O. (Cylindrus) carneola, *Lam.*	Fiji Islands. New Hebrides. Australia.
284. Olivella elongata, *Marrat.*	West Indies.
299. O. verreauxi, *Ducros.*	Antilles.
300. O. diadochus, *Ads. and Rve.*	do.
301. O. rubra, *Marrat.*	West Indies.
303. O. oryza, *Lam.*	Bahamas.
304. O. strigata, *Reeve.*	West Indies.
302. O. (Dactylidia) mutica, *Say.*	do.
51. O. (Callianax) biplicata, *Sow.*	California.
49. Ancilla candida, *Lam.*	
52. A. ampla, *Gmel.*	Red Sea.
306. A. glandis, *Lam.*	
871. A. crassa, *Sow.*	Suez.
45. Olivancillaria (Utriculina) litterata, *Lam.*	Florida.
50. O. (U.) gibbosa, *Born.*	Ceylon. Madras. Andaman Islands.

Section *TOXOGLOSSA* (Radula with normal formula, 1. 0. 1. Teeth large. Aesophagus with large poison gland).

Fam. Terebridae.

94.	Terebra dimidiata, *Linné.*	Society Islands.
98.	T. cingulifera, *Lam.*	Fiji Islands.
872.	T. myuros, *Lam.*	Moluccas.
875.	T. commaculata, *Gmel.*	Suez.
876.	T. subulata, *Linné.*	Red Sea.
874.	T. (Myurella) cancellata, *Quoy.*	New Hebrides.
92.	Acus [=Subula] maculata, *Linné.*	Fiji Islands.
93.	A. crenulata, *Lam.*	Society Islands. Fanning Island.
95.	A. muscaria, *Lam.*	Philippine Islands.
96.	A. tigrina, *Desh.*	Suez. New Hebrides.
97.	A. (Hastula) anomala, *Gray.*	Singapore.

Fam. Conidae.

101.	Conus marmoreus, *Linné.*	Singapore. New Hebrides.
102.	C. arachnoides, *Gmel.*	Ceylon. Andaman Islands.
103.	C. imperialis, *Linné.*	Philippine Islands.
117.	C. pennaceus, *Born.,* var. episcopus, *Lam.*	Andaman Islands.
360.	C. guinaicus, *Brug.*	
104.	C. (Stephanoconus) lividus, *Hwass.*	Philippine Islands.
352.	C. (S.) cedo-nulli, *Klein.*	Grand Cayman, W.I.
354.	C. (S.) mus, *Brug.*	Algiers.
358.	C. (S.) nebulosus, *Sol.*	Ceylon.
106.	C. (Puncticulus) ceylonicus, *Chem.*	do.
107.	C. (P.) pulicarius, *Brug.*	Pacific Islands.
1235.	C. (P.) arenatus (*Brug.*).	Red Sea. East Indies.
105.	C. (Coronaxis) hebræus, *Linné.*	Pacific Islands.
	var. vermiculatus, *Lam.*	Canton Islands.

353.	Nubecula tulipa, *Linné.*	Loyalty Islands.
878.	N. geographicus, *Linné.*	New Caledonia. Loyalty Islands.
108.	Dendroconus figulinus, *Linné.*	Philippine Islands.
351.	D. suratensis, *Hwass.*	
109.	D. (Lithoconus) millepunctatus, *Lam.*	Tahiti.
110.	D. (L.) tessellatus, *Born.*	Ceylon.
111.	D. (L.) virgo, *Linné.*	Friendly Islands.
348.	D. (L.) litteratus, *Linné.*	Ceylon. East Indies.
881.	D. (L.) eburneus, *Hwass.*	Fiji Islands. New Hebrides.
885.	D. (L.) flavidus, *Lam.*	Red Sea.
115.	Leptoconus amadis, *Martini.*	Ceylon.
361.	L. flavescens, *Gray.*	Bahamas.
1236.	L. thalassiarchus, *Gray.*	Philippine Islands.
1237.	L. augur, *Brug.*	
112.	L. (Rhizoconus) capitaneus, *Linné.*	Suez. Singapore.
113.	L. (R.) ermineus, *Born.*	Suez. Philippine Islands.
114.	L. (R.) generalis, *Linné.*	Moluccas.
153.	L. (R.) monile, *Brug.*	Singapore. Ceylon.
349.	L. (R.) miles, *Linné.*	Ceylon.
350.	L. (R.) mustelinus, *Hwass.*	Indian Ocean. North Australia.
877.	L. (R.) nemocamus, *Hwass.*	Aden.
116.	L. (Chelyconus) striatus, *Linné.*	Pacific Islands.
120.	L. (C.) ceciliæ, *Chenu.*	Suez.
356.	L. (C.) ochroleucus, *Gmel.*	
357.	L. (C.) testudinarius, *Mart.*	Panama.
880.	L. (C.) mediterraneus, *Hwass.*	Algiers.
118.	Cylinder textile, *Linné.*	Indian Ocean. New Hebrides.
355.	C. episcopus, *Hwass.*	Hawaiian Islands.
119.	Hermes solandri, *Brod.*	Philippine Islands.
882.	H. glans, *Hwass.*	Suez.

Fam. Pleurotomidae.

1188.	Bela [=Pleurotoma] turricula (*Mont.*).	(*British*, 525). Deerness, Orkney. Stonehaven. Firth of Forth.
1189.	B. rufa (*Mont.*).	(*do.* 534). Carnoustie. Firth of Forth. Falmouth.
	var. lactea.	Stonehaven.
1190.	Haedropleura [=Pleurotoma] costata (*da Costa*) [=septangularis].	(*British*, 538). Troon. South Coast.
1191.	Mangilia [=pleurotoma] costata (*Donovan*).	(*do.* 541). Carnoustie.
1192.	M. nebula (*Mont.*).	(*do.* 544).
14.	Pleurotoma babylonia, *Linné.*	Moluccas.
15.	P. garnonsii, *Reeve.*	do.
17.	P. tornatus, *Dillwyn.*	Indian Ocean.
886.	P. grandis, *Gray.*	
16.	Pleurotoma (Surcula) javana, *Linné.*	Straits of Malacca.
891.	P. (S.) tigrina, *Lam.*	New Hebrides.
267.	P. (S.) nodifera, *Lam.*	Moluccas. Ceylon.
892.	Drillia (Crassispira) bijubata, *Reeve.*	New Hebrides.
1193.	Clathurella [=Defrancia] linearis (*Mont.*).	(*British*, 550). Deerness, Orkney. Corrie, Arran. Helford River, Cornwall.
534.	C. purpurea (*Mont.*).	(*do.* 552). Falmouth, Cornwall.

Fam. Cancellariidae.

897.	Cancellaria cancellata, *Linné.*	Algiers.
898.	C. (Trigonostoma) scalarina, *Chem.*	

Order **OPISTHOBRANCHIATA.** (Breathing organs, when present, behind the heart.)

Sub-order *TECTIBRANCHIATA.* (Right breathing organ more or less concealed by the mantle.)

Fam. Actæonidae.

899.	Actæon tornatilis (*Linné*).	(*British*, 553). St. Andrews. Ayr. South Coast.
900.	A. (Buccinulus) affinisa, *A. Adams.*	Port Jackson, Sydney (Chal. Exped.).
305.	Volvaria [=Cylichna] varia, *Sow.*	

Fam. Tornatinidae.

1194. Tornatina [=Utriculus] truncatula (*Brug.*). (*British*, 556). Helford River, Cornwall.
902. T. obtusa (*Mont.*). (*do.* 557). St. Andrews. Tenby, Wales.
1638. T. umbilicata (*Mont.*). (*do.* 559). Elie, Fife.
1639. Diaphana [=Utriculus] expansa (*Jeff.*). (*do.* 562). do. do.
1640. D. hyalina (*Turt.*). (*do.* 563). do. do.

Fam. Scaphandridae.

903. Scaphander lignarius (*Linné*). (*British*, 566). St. Andrews. English Channel.
905. Bullinella [=Cylichna] cylindracea (*Penn.*). (*do.* 569). St. Andrews. Tenby, Wales. South Brittany.
906. Atys cylindrica, *Helb.* Fiji Islands. New Hebrides.
205. A. naucum, *Linné.* Ceylon.

Fam. Bullidae.

204. Bulla ampulla, *Linné.* Tahiti.
431. B. amygdala, *List.* Algiers. Suez. Port Said. Grand Cayman, W.I.
907. B. adamsi, *Menke.* New Hebrides.
1195. Haminea [=Bulla] hydatis, *Linné.* (*British*, 572).
1384. Acera bullata, *Müll.* (*do.* 575). Channel Islands.

Fam. Philinidae.

908. Philine aperta (*Linné*). (*British*, 583). Granton, Forth. Tenby, Wales. Helford River and Falmouth, Cornwall. Suez.
1641. P. scabra (*Müll*). (*do.* 576). Newhaven, Forth.
1642. P. catena (*Mont.*). (*do.* 577). Elie, Fife.
1643. P. angulata, *Jeff.* (*do.* 578). do. do.

Fam. Aplysiidae.

1196. Aplysia punctata, *Cuv.* (*British*, 590).

Fam. Pleurobranchidae.

1197. Oscanius [=Pleurobranchus] membranaceus (*Mont.*). (*British*, 595). Teignmouth.

Fam. Siphonariidae.

909. Siphonaria costata, *Sow.* Central America.

Sub-order *PTEROPODA* ("Wing-footed." Pelagic Mollusca).

Section *THECOSOMATA* (Shell always present. Fins connected by a lobe).

Fam. Cavoliniidae.

997. Cavolinia [=Hyalæa] tridentata, *Gmel.* Atlantic. Mediterranean.
1001. Clio (Crescis) aciculata, *Rang.* Atlantic.

Order **PULMONATA** ("Lung-breathers." Mostly Inoperculate Land and Freshwater Mollusca).

Fam. Auriculidae.

1312. Carychium minimum, *Müll.* (*Brit. L.* and *F.-W.*, 113; *Perth.*, 60). Perthshire. Burntisland. The Hague, Holland.
1199. Phytia [=Alexia] myosotis (*Drap.*) [=denticulata]. (*British*, 703; *Brit. L.* and *F.-W.* 115). Faversham and Erith, Kent. Abbeville, France.
1198. Ovatella [=Leuconia] bidentata (*Mont.*). (*do.* 702; *do.* 116). Tenby, Wales. Teignmouth.
1388. Melampus coffeus, *Linné.* Grand Cayman, West Indies.
1389. M. castaneus, *Mühlf.* Bushire, Persian Gulf.
1390. M. flavus, *Gmel.* New Hebrides.
1394. M. fasciatus, *Desh.* do.
1392. M. (Tralia) pusillus, *Gmel.* West Indies.
1391. Auricula auris-midæ, *Linné.* Borneo.
1393. Cassidula doliolum, *Petit.* Suez.
1203. Scarabus lessoni, *Blainv.* New Hebrides.

Fam. Otinidae.

1385.	Otina otis (*Turton*).	(*British*, 701). Channel Islands.

Fam. Amphibolidae.

283.	Amphibola nux-avellana, *Chem.*	New Zealand.
1591.	A. australis.	do.
1592.	A. (Ampullarina) fragilis, *Q. and G.*	Victoria, Australia.

Fam. Ancylidae.

1315.	Ancylus fluviatilis, *Müll.*	(*Brit. L.* and *F.-W.*, 117; *Perth.*, 61). Perthshire. Braemar.
1316.	Acroloxus lacustris (*Linné*) [=oblongus, *Lightfoot*].	(*do.* 118; *do.* 62). do. Hale, Cheshire.

Fam. Limnaeidae.

1317.	Limnæa (Radix) auricularia (*Linné*).	(*Brit. L.* and *F.-W.*, 119). Near London. Cambridge. Abbeville, France.
	var. acuta, *Jeffreys.*	Gravony, Kent; Goodneston.
1318.	L. (R.) pereger (*Müll.*).	(*Brit. L.* and *F.-W.*, 120; *Perth.*, 63). Perthshire. Croydon. Abbeville, France.
	var. picta, *Jeff.*	Derby.
	var. boissyi, *Dupuy.*	Tents Muir, Fife.
	var. accuminata, *Jeff.*	Smallheath, Birmingham.
	var. intermedia, *Fér.*	
1320.	L. palustris (*Müll.*).	(*Brit. L.* and *F.-W.*, 121; *Perth.*, 65). Perthshire. Lewes, Sussex. Abbeville, France. Walchenser, Bavaria.
	var. tincta, *Jeff.*	St. Nicholas Marshes, East Kent.
1321.	L. truncatula (*Müll.*).	(*Brit. L.* and *F.-W.*, 122; *Perth.*, 66). Perthshire.
1322.	L. stagnalis (*Linné*).	(*do.* 123). Cambridge. Croydon. Abbeville, France.
	var. bottnica, *Clessin.*	Chislehurst, Kent.
	var. labiata, *Jeff.*	Poynton, Cheshire.

1323.	L. (Leptolimnæa) glabra (*Müll.*).	(*Brit. L.* and *F.-W.*, 124; *Perth.*, 67). Perthshire.
1319.	L. (Cyclolimnæa) burnetti, *Ald.* [=L. pereger, var. burnetti (*Ald.*)].	(*do.* 125; *do.* 64). do.
1324.	Amphipeplea [=Limnæa] glutinosa (*Müll.*).	(*do.* 128). Sandwich, Kent. Ryland.
1395.	L. (Limnophysa) pinguis, *Dohrn.*	Colombo, Ceylon.

Fam. Planorbidae.

1396.	Planorbis (Coretus) exustus, *Desh.*	Calcutta.
1325.	P. (C.) corneus, *Linné.*	(*Brit. L.* and *F.-W.*, 129). Cambridge. Abbeville, France.
1326.	P. (Gyraulus) albus, *Müll.*	(*do.* 130; *Perth.*, 68). Perthshire. Leicestershire.
1327.	P. (G.) lævis, *Ald.* [=glaber, *Jeff.* =parvus, *Say.*].	(*do.* 133; *do.* 69). Tuxford. Newark.
1328.	P. (G.) crista (*Linné*) [=nautileus (*Linné*)].	(*do.* 134; *do.* 70). Perthshire. Kenton, Northumberland.
1329.	P. (G.) dilatatus, *Gould.*	(*do.* 135). Canals, Manchester.
1330.	P. carinatus, *Müll.*	(*do.* 136). Marple, Cheshire. Cambridge. Abbeville, France.
1331.	P. umbilicatus, *Müll.* [=marginatus, *Drap.* =complanatus, *Jeff.*].	(*do.* 137). Croydon, Surrey. Cambridge. Abbeville, France.
1332.	P. vortex (*Linné*).	(*do.* 138). Croydon, Surrey. Cambridge. Abbeville, France.
1333.	P. leucostoma, *Millet.* [=spirorbis (*Linné*)].	(*do.* 141; *Perth.*, 71). Perthshire. Marsdon, Durham. The Lizard, Cornwall.
1334.	P. (Bathyomphalus) contortus (*Linné*).	(*do.* 142; *do.* 72). Perthshire. Croydon.
1335.	P. (Hippeutis) fontanus (*Lightfoot*) [=nitidus (*Müll.*)].	(*do.* 143; *do.* 73). Perthshire. Near London.
1397.	P. (Planorbella) campanulatus, *Say.*	United States, America.
1336.	Segmentina [=Planorbis] nitida, *Müll.* [=lineata, *Walker*].	(*Brit. L.* and *F.-W.*, 144). Bral, Kent. Barnes, Surrey.

Fam. Physidae.

1398. Physa acuta, *Drap.* — Bordeaux, France.
1337. P. fontinalis (*Linné*). — (*Brit. L. and F.-W.*, 145; *Perth.*, 74). Perthshire. Edinburgh. Rusholme, Manchester.
1338. Aplecta [=Physa] hypnorum (*Linné*). — (*do.* 148; *do.* 75). Perthshire. Cardiff.

Fam. Chilinidae.

533. Chilina cepuelca, *D'Orb.* — Patagonia.

Fam. Streptaxidae.

1523. Gibbus palanga, *Fér.* — Mauritius.
1603. G. lyonetianus, *Pallas.* — do.

Fam. Testacellidae.

1240. Testacella maugei, *Fér.* — (*Brit. L. and F.-W.*, 1). Cornwall.
1242. T. scutulum, *Sow.* [=T. haliotidea, *Drap.*, var. scutulum, *Moq.-Tand.*]. — (*do.* 3; *Perth.*, 1). Perthshire. Kirkcaldy, Fifeshire.

Fam. Oleacinidae.

294. Oleacina [=Glandina] vanuxemensis, *Lea.* — Pichincha, Ecuador.

Fam. Limacidae.

1243. Limax (Heynemannia) maximus, *Linné.* — (*Brit. L. and F.-W.*, 4; *Perth.*, 2). Perthshire.
1244. L. (Lehmannia) flavus, *Linné.* — (*do.* 7). Manchester.
1245. L. (L.) arborum, *Bouch-Chant.* [=marginatus, *Müll.*]. — (*do.* 8; *Perth.*, 5). Perthshire. Faversham, Kent.
1246. Agriolimax [=Limax] agrestis (*Linné*). — (*do.* 10; *do.* 6). Perthshire. Faversham, Kent.
1247. A. lævis (*Müll.*). — (*do.* 11; *do.* 7). Perthshire. Twickenham.

Fam. Vitrinidae.

1248. Vitrina pellucida (*Müll.*). — (*Brit. L. and F.-W.*, 15; *Perth.*, 10). Perthshire.

Fam. Zonitidae.

1411.	Omphalina (Morelitia) euryomphala, *Pfr.*	Pichincha, Ecuador.
1539.	O. (Ægopina) incerta, *Drap.*	San Sebastian.
1249.	Vitrea [=Hyalinia] crystallina (*Müll.*).	(*Brit. L.* and *F.-W.*, 17; *Perth.*, 11). Perthshire. The Hague, Holland.
1250.	Polita [=Hyalinia] draparnaudi (*Beck.*) [=lucida (*Drap.*)].	(*do.* 18; *do.* 12). Perthshire.
1251.	P. cellaria (*Müll.*).	(*do.* 19; *do.* 13). Perthshire. Colvend, Kirkcudbrightshire. Abbeville, France. Schaffhausen, Switzerland. Belluno, Italy.
1252.	P. rogersi, *B. B. Woodward* [=helvetica, *Blum.* =glabra, *Jeff.*].	(*Brit. L.* and *F.-W.*, 22; *Perth.*, 14). Orpington, Kent.
1253.	P. alliaria (*Miller*).	(*do.* 23; *do.* 15). Perthshire. Schaffhausen, Switzerland.
1254.	P. nitidula (*Drap.*).	(*do.* 24; *do.* 16). Perthshire. Colvend, Kirkcudbrightshire. Wickham, Newcastle. Falmouth, Cornwall.
	var. helmi, *Ald.*	Orpington, Kent.
1255.	Polita pura (*Ald.*).	(*Brit. L.* and *F.-W.*, 25; *Perth.*, 17). Perthshire. Schaffhausen, Switzerland.
1256.	P. radiatula (*Ald.*).	(*do.* 26; *do.* 18). Perthshire.
1399.	P. algirus (*Linné*).	Cannes.
1258.	Zonitoides nitidus (*Müll.*).	(*Brit. L.* and *F.-W.*, 27; *Perth.*, 20). Colvend. Strathglass, Inverness-shire. Twickenham.
1259.	Z. excavatus (*Bean.*).	(*do.* 28; *do.* 21). Colvend.
1257.	Euconulus [=Zonites] fulvus (*Drap.*).	(*do.* 30; *do.* 19). Perthshire. The Lizard, Cornwall. The Hague, Holland.
206.	Nanina (Rhysota) ovum, *Valen.*	Philippine Islands.
207.	N. (R.) lamarkiana, *Pfr.*	do.
1401.	N. (R.) maxima, *Pfr.*	do.

1402.	N. (R.) müleri, *Pfr.*	Philippine Islands. (Calipan, Mindoro.)
1403.	N. (R.) universicolor, *Fér.*	Mauritius.
1404.	N. (Hemiplecta) rumphi, *Busch.*	Java.
1405.	N. (H.) heptagyra, *Möllff.*	do.
1406.	N. (H.) gemina, *Busch.*	do.
1407.	N. (H.) acuticarinata, *Möllff.*	do.
1408.	N. (H.) complanata, *Möllff.*	do.
1400.	Xesta rareguttata, *Mouss.*	do.
1409.	X. cochlostyloides, *Schep.*	do.
1412.	X. (Xestina) inflata, *Möllff.*	do.
1410.	Macrochlamys vitrinoides, *Desh.*	Calcutta.
1440.	Trochomarpha menuziana, *Pfr.*	Palma, Majorca.

Fam. Arionidae.

1260.	Arion ater (*Linné*).	(*Brit. L.* and *F.-W.*, 31; *Perth.*, 22). Perthshire.
1261.	A. subfuscus (*Drap.*) [=flavus, *Pollon.*].	(*do.* 32; *do.* 23). do.
1262.	A. hortensis, *Fér.*	(*do.* 34; *do.* 25). do.
1263.	A. circumscriptus, *Johnston* [=bourquignati, *Mabille*].	(*do.* 35; *do.* 26). do.

Fam. Endodontidae.

1264.	Punctum [=Helix] pygmæum (*Drap.*).	(*Brit. L.* and *F.-W.*, 37; *Perth.*, 27). Perthshire.

Fam. Pyramidulidae.

1413.	Pyramidula [=Helix] alternata, *Say.*	Orme, France; North America.
1265.	P. rupestris (*Drap.*).	(*Brit. L.* and *F.-W.*, 38; *Perth.*, 28). Perthshire. Mansal Dale, Derbyshire.
1266.	P. (Goniodiscus) rotundata (*Müll.*).	(*do.* 40; *do.* 29). Perthshire. Croydon, Surrey. Orpington, Kent. Torquay, Devon. The Hague, Holland. Schaffhausen, Switzerland.
	var. alba, *Moq.-Tand.*	Perthshire.

Fam. Helicidae.

1426.	Polygyra (Mesodon) albolabris, *Say.*	North America.
1438.	Pleurodonte patina, *C. B. Adams.*	
1439.	P. okeniana, *Pfr.*	China.
1553.	P. sinuata, *Müll.*	Jamaica.
1554.	P. picturata, *C. B. Adams.*	do.
1436.	P. (Isomeria) oreas, *Koch.*	Pichincha, Ecuador.
1437.	P. (I.) bourcieri, *Pfr.*	do. do.
1435.	Obba bituberculata, *Pfr.*	do. do.
208.	O. marginata, *Miller.*	Philippine Islands.
210.	O. rota, *Brod.*	do.
209.	Planispira zonaria, *Linné.*	Moluccas.
	var. coluber, *Beck.*	Java.
1458.	Thersites fraseri, *Gray.*	Queensland, Australia.
1457.	Pedinogyra cunninghami, *Gray.*	do. do.
1597.	Panda falconari, *Reeve.*	New South Wales.
212.	Epiphragmophora fidelis, *Gray.*	Oregon, N. America.
1451.	Papuina trochiformis, *Preston.*	Dutch New Guinea.
1443.	Acavus hæmastoma, *Linné.*	Ceylon.
1444.	A. phœnix, *Pfr.*	do.
1540.	A. grevillei.	do. (Colombo).
1580.	Ampelita sepulchralis, *Fér.*	Madagascar.
1419.	Eulota fruticum (*Müll*).	(*Brit. L.* and *F.-W.*, 43). Tyrol.
1453.	E. (Plectotropis) mackenzii, *Ad. and Rve.*	Philippine Islands.
1454.	E. (Euhadra) subtrizona, *Möllff.*	Java.
1455.	E. (E.) fuscozonia, *Möllff.*	do.
1456.	E. (E.) myomphala, *Mrts.*	do.
1479.	Crystallopsis tricolor, *Pfr.*	Solomon Islands.
1598.	C. woodfordi, *Sow.*	do.

997.	Cochlostyla (Corasia) ægrota, *Reeve.*	Mindoro, Philippine Islands.
1583.	C. (C.) sphærion, *Sow.*	Bohol, do.
211.	C. (Calocochlea) melanocheila, *Val.*	do.
1557.	C. (C.) dimera, *Jonas.*	Toblas, do.
1562.	C. (C.) polillensis, *Pfr.*	Polill, do.
1563.	C. (C.) pulcherrima, *Sow.*	Luzon, do.
1565.	C. (C.) roissyana, *Fér.*	Mindoro, do.
1584.	C. (C.) coccomelos, *Sow.*	Toblas, do.
1585.	C. (C.) mindanensis, *Sow.*	Mindan, do.
1476.	C. (Helicostyla) metaformis, *Sow.*	Luzon, do.
1558.	C. (H.) hydrophana, *Sow.*	Cavite, do.
1586.	C. (Cochlodryas) polychroa, *Sow.*	Buriss, do.
1001.	C. (Pachysphæra) annulata, *Sow.*	Ilocos, do.
1559.	C. (P.) iliconensis, *Sow.*	do. do.
1566.	C. (P.) sphærica, *Sow.*	do. do.
1552.	C. (Columplica) cepoides, *Lea.*	do.
1459.	C. (Helicobulinus) sarcinosa, *Fér.*	Negros, do.
213.	C. (Orthostyla) rufogaster, *Sesson.*	do.
1556.	C. (O.) decorata, *Fér.*	Guimaras, do.
1561.	C. (O.) palawanensis, *Pfr.*	Palawan, do.
1517.	C. (O.) alberti, *Sow.*	Luzon, do.
1567.	C. (O.) nimbosa, *Brod.*	Negros, do.
1568.	C. (O.) pythogaster, *Fér.*	Marinduque, do.
1571.	C. (O.) satyrus, *Brod.*	Banquey, do.
1587.	C. (O.) faunus, *Brod.*	Lebu, do.
1588.	C. (O.) guimarasensis, *Brod.*	Guimaras, do.
1569.	C. (Hypselostyla) boholensis, *Brod.*	Bohol, do.
1570.	C. (H.) concinna, *Sow.*	Barias, do.
1478.	C. (Eudoxus) smaragdina, *Reeve.*	do.

1564.	C. (E.) quadrasi, *Hid.*	Marinduque,	Philippine Islands.
1560.	C. (Canistrum) ovoidea, *Brug.*	Masbate,	do.
1572.	C. (C.) balanoidea, *Jonas.*	Luzon,	do.
1573.	C. (C.) partuloides, *Brod.*	Mindoro,	do.
1589.	C. (Prochilus) dryas, *Brod.*	do.	do.
1590.	C. (P.) virgata, *Jay.*	do.	do.
1477.	C. (Chrysallis) mindoroënsis, *Brod.*	do.	do.
1574.	C. (C.) chrysalidiformis, *Sow.*	do.	do.
1475.	Amphidromus metabletus, *Mölldff.*	Java.	
	vars. alba, fusca, flava, trizona, tritæniata, and pachychilus.	do.	
1480.	A. poecila, *Bttgr.*	do.	
1481.	A. subcostulata, *Bttgr.*	do.	
1482.	A. virescens, *Marts.*	do.	
1483.	A. ineuris, *Bttgr.*	do.	
1484.	A. inconstans, *Fulton.*	do.	
1486.	A. semirugosa.	do.	
1494.	A. palaceus, *Mouss.*	do.	
	vars. apressa and pura.	do.	
1488.	A. sumbaënsis, *Fulton.*	do.	
1489.	A. augusta, *Bttgr.*	do	
1490.	A. ventrosula, *Mölldff.*	do.	
1491.	A. porcellanus, *Mouss.*	do.	
1492.	A. strigosous, *Marts.*	Celebes.	
1493.	A. impunctatus, *Mölldff.*	Java.	
1495.	A. galericulum, *Bttgr.*, var. gedeana.	do.	
1496.	A. rhodostylus, *Mölldff.*, vars. simplex, ignea, and subconfluens.	do.	
1497.	A. macassariens, *Fac.*	Celebes,	

1498. A. polymorphus, *T. Canefri.*	Asia.
1499. A. interruptus, *Müll.*	Java.
1500. A. perversus, *Linné.*	Ceylon.
1602. A. dohrni, *Pfr.*	Java.
1414. Leucochroa (Macularia) serpentinus, *Fér.*	Colisseum, Rome.
1429. L. tumulorum, *Webb and Berth.*	Canary Islands.
1430. L. candidissimus, *Drap.*	Mentone, France. Well of Baths, Palestine.
1447. L. filia, *Mouss.*	Jebel Usneder, Dead Sea, Palestine.
1267. Helicella (Heliomanes) virgata (*Da Costa*).	(*Brit. L.* and *F.-W.*, 44; *Perth.*, 30). Perthshire. Troon, Ayrshire. Cambridge. Lewes, Sussex. Towyn, Merionethshire. Llandudno, North Wales. Lizard, Land's End, and St. Ives, Cornwall. Palma, Majorca.
var. picturata.	Bordeaux, France.
1268. H. itala (*Linné*) [=ericetorum, *Müll.*].	(*Brit. L.* and *F.-W.*, 45). Land's End. Cambridge. Iona. Portrush. Peronne, France.
var. alba, *Charp.*	Lewes, Sussex.
1269. H. (Candidula) caperata (*Mont.*).	(*Brit. L.* and *F.-W.*, 47). Monifieth, Forfar. Burntisland, Fife. Colvend, Kirkcudbright. Corrie, Arran. Croydon. Longpré, France. Larnica, Cyprus.
var. major.	Berwick.
1469. H. (C.) gigaxii (*Charp.*).	(*Brit. L.* and *F.-W.*, 48). Palma, Majorca. Larnica, Cyprus.
1431. H. (Jacosta) syrensis, *Pfr.*	Wilderness of Judea, Palestine.
1270. Cochlicella barbara (*Linné*) [=Bulimus acutus, *Müll.*].	(*Brit. L.* and *F.-W.*, 50). Troon. Lizard and Land's End. Portrush and Donegal, Ireland. Larnica, Cyprus. Palma, Majorca.
var. bizona, *Moq.-Tand.*	Tenby, Wales. Portrush, Ireland.
1271. Theba [=Helix] cantiana (*Mont.*).	(*Brit. L.* and *F.-W.*, 51). Cambridge. Croydon. Longpré, Somme, France.
1272. T. carthusiana (*Müll.*).	(*do.* 52). Lewes, Sussex. Larnica, Cyprus.

1415.	T. candicans, *Ziegl.*	Innsbruck, Switzerland.
1423.	T. syriaca, *Ehrenb.*	Mount Carmel, Palestine.
1416.	T. (Irus) apicina, *Lam.*	Tangiers.
1274.	Hygromia (Fruticicola) fusca (*Mont.*).	(*Brit. L.* and *F.-W.*, 53; *Perth.*, 32). Perthshire.
1273.	H. (F.) granulata (*Ald.*) [=Ashfordia sericea, *Jeffr.*].	(*do.* 54; *do.* 31). Cornwall.
1275.	H. (F.) hispida (*Linné*).	(*do.* 56; *do.* 33). Perthshire. Wickham, Durham. Cockington, Devon. Schaffhausen, Switzerland.
1276.	H. (F.) striolata, *Pfr.* [=Helix rufescens, *Mont.*].	(*do.* 57; *do.* 34). Perthshire. Lochmaben, Dumfries. Cambridge. Derby. Croydon. Torquay and Cockington, Devon.
1277.	H. (F.) revelata (*Fér.*).	(*do.* 58). Sark, Channel Islands.
1422.	H. (F.) umbrosa, *Partsch.*	Jenbach, Switzerland.
1544.	H. (Perforatella) unidentata, *Drap.*	Bavarian Alps.
1418.	H. limbata, *Drap.*	Rouen, France. Perarola, Italy.
1420.	H. incarnata, *Müll.*	Northern Tyrol, Algiers.
1421.	H. flavida, *Zeigl.*	Belluna and Perarola, Italy.
1278.	Acanthinula [=Helix] aculeata (*Müll.*).	(*Brit. L.* and *F.-W.*, 60; *Perth.*, 35). Perthshire. Porthcurnow, Cornwall.
1279.	A. lamellata, *Jeffr.*	(*do.* 61; *do.* 36). Perthshire. Strathglass, Inverness-shire.
1280.	Vallonia [=Helix] pulchella (*Müll.*).	(*do.* 62; *do.* 38). Perthshire. Whitley, Northumberland.
1610.	V. excentrica, *Sterki.*	(*do.* 63). Bradford, Yorkshire.
1281.	V. costata (*Müll.*).	(*do.* 65; *Perth.*, 37). Perthshire.
1282.	Helicodonta [=Helix] obvoluta (*Müll.*).	(*do.* 66). Hampshire. Heidelberg, Germany. Brugg and Schaffhausen, Switzerland. Predazzo and Como, Italy.
1427.	H. (Carocollina) tarnieri, *Morelet.*	Tangiers.
1283.	Helicigona lapicida (*Linné*).	(*Brit. L.* and *F.-W.*, 67). Hereford. Torquay. Devon. Schaffhausen, Switzerland.

1551. H. setosa, *Zgl.* Pichincha, Ecuador.
1432. H. (Campylæa) corneus, *Drap.* Bordeaux, France.
1433. H. (C.) preslii, *Ziegl.* Achenthal, Tyrol.
1542. H. (C.) cryptozona, *Mulhf.* Perarola, Italy.
1543. H. (C.) faustina, *Zeigl.* Predazzo, Italy.
1425. Anchistoma personatum, *Lam.* Tutzing, Switzerland.
1284. Arianta [=Helix] arbustorum (*Linné*). (*Brit. L.* and *F.-W.*, 68; *Perth.*, 39). Perthshire. Abbeville, France. Grindelwald, Interlaken, and Mittewald, Switzerland.
var. flavescens, *Moq.-Tand.* Cambridge. Derbyshire. Schaffhausen and Tunthal, Switzerland.
1286. Helix (Helicogena) aspersa, *Müll.* (*Brit. L.* and *F.-W.*, 69; *Perth.*, 40). Perthshire. Balmano, Fife. Cambridge. Portrush, Ireland. Abbeville, France. [The Common Garden Snail.]
var. grisea. Torquay, Devon.
var. exalbida, *Menke.* Warlingham, Surrey.
1285. H. (H.) pomatia, *Linné.* (*Brit. L.* and *F.-W.*, 70). Cambridge. Gloucester. Croydon. Abbeville, France. Perarola, Primiera and Belluno, Italy. Larnica, Cyprus.
1441. H. (H.) melanostoma, *Drap.* Alexandria, Egypt.
1442. H. (H.) aperta, *Born.* Italy.
1287. H. (Cepæa [=Tachea]) nemoralis, *Linné.* (*Brit. L.* and *F.-W.*, 71; *Perth.*, 41). Perthshire. Cambridge. Portrush, Ireland. Peronne, Somme, France. Perarola, Italy.
var. olivacea, *Risso.* Teignmouth, Devon.
var. cincta. Auchendrane, Ayr. Portrush, Ireland. Peronne and St. Valery, France.
var. lutea. Abbeville, France. Mainz, Germany. Geneva, Switzerland.
var. libellula, *Risso.* Abbeville and Peronne, France.
var. hybrida. Hereford.

1288. H. (C.) hortensis, *Müll.*	(*Brit. L.* and *F.-W.*, 72; *Perth.*, 42). Perthshire. Abbeville, Somme, France.
1445. H. (C.) sylvatica, *Drap.*	Lucerne and Schaffhausen, Switzerland.
1447. H. (C.) orgia.	Valentia, Spain. Algiers.
1446. H. (Otala) lactea, *Müll.*	Malaga, Spain.
1448. H. (O.) vermiculata, *Müll.*	St. Paul's Bay, Malta. Larnica, Cyprus.
1449. H. (O.) zaffarina, *Beck.*	Algiers.
1450. H. (O.) heiroglyphicula, *Mich.*	Oran. Algiers.
1434. H. (Levantina) spiriplana, *Oliv.*	South of Europe. Jerusalem, Palestine.
1289. H. (Euparypha) pisana (*Müll.*).	(*Brit. L.* and *F.-W.*, 73). Cambridge. Tenby, Wales. Abbeville and Arcachon, France. Perarola and Pozzuoli, Italy. Larnica, Cyprus. Algiers. Alexandria, Egypt.
var. alba, *Shuttleworth.*	St. Paul's Bay, Malta. [A. Coates, 1877.]

Fam. Acavidae.

1468. Bulimus (Borus) popelairianus, *Nyst.*	Ecuador.
1470. B. (B.) oblongus, *Müll.*	Gualea, Pichincha, Ecuador. 5,000 to 12,000 ft. [L. Söderstrom.]
1471. B. (Dryptus) irroratus, *Reeve.*	do. do. do. do. do.

Fam. Bulimulidae.

1604. Auris auris-scuiri, *Guppy.*	Trinidad.
1605. A. melastoma, *Swain.*	Brazil.
1606. Bulimulus (Zaplagius) auris-leporis, *Brug.*	do.
1474. B. guadalupensis, *Brug.*	Porto Rico.
1501. B. (Plectostylus) peruvianus, *Brug.*	Peru.
1502. B. (P.) chilensis, *Less.*	Chile.
1503. B. (P.) multicolor, *Reeve.*	Pichincha, Ecuador. 5,000 to 12,000 ft. [L. Söderstrom.]
1504. B. (Plecocheilus) taylorianus, *Reeve.*	do. do. do. do.
1508. B. (Drymæus) fallax, *Pfr.*	do. do. do. do.
1509. B. (D.) felix, *Pfr.*	do. do. do. do.

1510.	B. (Navicula) navicula, *Wagn.*	Brazil.
1505.	Placostylus (Aspastus) miltocheilus, *Reeve.*	Solomon Islands.
1582.	P. (Placocharis) palmarum, *Angas.*	do.
1506.	P. (P.) founaki, *Hom.*	New Caledonia.
1581.	Placostylus (Eumecostylus) cleryi, *Petit.*	do.
293.	Odontostomus (Bahiensis) punctatissimus, *Less.*	Brazil.

Fam. Orthalicidae.

1460.	Orthalicus zebra, *Müll.* [=undatus, *Brug.*].	Pichincha, Ecuador, Brazil.

Fam. Cylindrellidae [=Urocoptidae].

1374.	Cylindrella [=Urocoptis] cylindrus, *Pfr.*	Jamaica.

Fam. Cerionidae.

216.	Cerion [=Strophia] glans, *Küster.*	West Indies.
1520.	C. martinianum, *Küster.*	Grand Cayman, West Indies.
1521.	C. uva, *Linné.*	Curaçoa, West Indies.
1522.	C. marmoratum, *Pfr.*	Bahamas.

Fam. Enidae.

1290.	Ena [=Bulimus] montana (*Drap.*).	(*Brit. L.* and *F.-W.*, 74). Oxfordshire. Bavarian Alps.
	var. pallescens.	Oxfordshire.
1291.	E. obscura (*Müll.*).	(*Brit. L.* and *F.-W.*, 75; *Perth.*, 43). Perthshire. Teignmouth.
1466.	E. tupacii, *D'Orb.*	Chulumani, Bolivia. 2,000 metres.
1461.	E. (Zebrina) detritus, *Müll.*	Heidelberg, Germany. Schaffhausen, Switzerland.
1465.	E. (Subzebrinus) candelaris, *Pfr.*	Tibet.
1472.	E. (Petræus) carneus, *Pfr.*	Masada, Dead Sea, Palestine.
1473.	E. (Coccoderma) tenuiliratus, *Möllff.*	Java.
1464.	Condrula septemdentatis, *Roth.*	Mount Carmel, Palestine.

Fam. Stenogyridae [=Achatinidae].

1607.	Pseudachatina downesi, *Gray*.	West Africa.
1608.	P. wrighti, *Sow*.	Africa.
1609.	Columna flammea, *Müll*.	Princes' Island, Gulf of Guinea.
214.	Achatina immaculata, *Lam*.	South Africa.
1515.	A. sinistrorsa, *Chem*.	do.
1516.	A. variegata, *F. Colum*.	do. [The " Giant Agate Snail," the largest land mollusk.]
1593.	A. (Archachatina) marginata, *Swain*.	do.
1594.	A. (A.) purpurea, *Lam*.	do.
1514.	A. (Cochlitoma) zebra, *Chem*.	do.
1600.	Porphyrobaphe iostoma, *Sow*.	South America.
1599.	Liguus virgineus, *Linné*.	West Indies.
1463.	Rumina decollata, *Linné*.	Alexandria, Egypt.
1512.	Homorus castanea, *Marts*.	Africa.
1511.	Stenogyra [=Obeliscus] calcarea, *Born*.	Bahia, Brazil.
1615.	Opeas goodalli (*Miller*).	(*Brit. L.* and *F.-W.*, 76). A West Indian alien, introduced into greenhouses in this country, from Herts. to Cumberland.
1519.	Subulina octona, *Chem*.	(*Brit. L.* and *F.-W.*, 78). An American alien, introduced into greenhouses in this country, from Lanark to Surrey.
1518.	S. rangiana, *Pfr*.	Pichincha, Ecuador.
1292.	Cochlicopa [=Zua] lubrica (*Müll*.).	(*Brit. L.* and *F.-W.*, 80; *Perth.*, 44). Perthshire.
1293.	Azeca menkeana (*Pfr*.) [=tridens (*Pult*.)].	(*do.* 81; *do.* 45). Chelmsford, Essex. Brighton, Sussex.
1294.	Cæcilioides [=Achatina] acicula (*Müll*.).	(*do.* 82). York.

Fam. Pupillidae.

1259. Pupilla [=Pupa] muscorum (*Linné*) [=marginata, *Drap*.]. (*Brit. L.* and *F.-W.*, 83). Whitley, Northumberland. Pontefract, Yorkshire.

1296. Lauria [=Pupa] cylindracea, *Da Costa* [=umbilicata, *Drap.*]. (*Brit. L.* and *F.-W.*, 84; *Perth.*, 46). Perthshire.
1297. L. anglica, *Fér.* [=ringens, *Jeffr.*]. (*do.* 85; *do.* 47). Faversham, Kent.
1298. Abida [=Pupa] secale (*Drap.*). (*do.* 86). Dorset. Rouen, France. Schaffhausen, Switzerland. Bellagio, Italy.

Fam. Vertiginidae.

1299. Vertigo (Isthmia) antivertigo, *Drap.* (*Brit. L.* and *F.-W.*, 88; *Perth.*, 48). Perthshire. Bristol.
1300. V. (I.) substriata (*Jeffr.*). (*do.* 89; *do.* 49). Greenlaw, Berwickshire.
1301. V. (I.) pygmæa (*Drap.*). (*do.* 90; *do.* 50). Perthshire. Anglesea, Wales.
1611. V. (I.) moulinsiana (*Dupuy*). (*do.* 92). Morden, Dorset.
1612. V. (I.) alpestris, *Ald.* (*do.* 94). West Yorkshire.
1613. V. (I.) pusilla, *Müll.* (*do.* 95). Heller Wood, Yorkshire.
1614. V. (I.) angustior, *Jeff.* (*do.* 96). Suffolk.
1302. Columella [=Sphyradium] edentula (*Drap.*). (*do.* 97; *Perth.*, 52). Perthshire.
1303. C. minutissima (*Hartmann*). (*do.* 99; *do.* 53). do.

Fam. Clausiliidae.

1304. Balea perversa (*Linné*). (*Brit. L.* and *F.-W.*, 100; *Perth.*, 54). Perthshire. Teignmouth, Devon.
1305. Clausilia (Marpessa) laminata (*Mont.*). (*do.* 101; *do.* 55). Perthshire. Oxfordshire. Wark, Northumberland. Schaffhausen, Switzerland.
var. albina, *Moq.-Tand.* Oxfordshire. Lewes, Sussex.
1306. C. (Alinda) biplicata (*Mont.*). (*Brit. L.* and *F.-W.*, 102). Hammersmith. Lucerne, Switzerland.
1528. C. (Pirostoma) parvula, *Stud.* (*do.* 103). Bavarian Alps. Lucerne, Switzerland.
1204. C. (P.) dubia, *Drap.* (*do.* 104). Tunstall. Sunderland.
1307. C. (P.) bidentata (*Ström.*). (*do.* 105; Perth., 56). Perthshire. Colvend, Kirkcudbright. Torquay, Devon. Schaffhausen, Switzerland.

1308. C. (P.) rolphii, *Leach.* — (*Brit. L.* and *F.-W.*, 108). Cheltenham.
1541. C. rubiginea. — Coliseum, Rome, Belluno, Cortina, Bellagio, and Como, Italy. Palma, Majorca.
1527. C. syracusana, *Phil.* — Sicily.
1555. C. circinata, *Paul.* — Palma, Corsica.
1526. C. dalmatina, *Partsch.* — Vergoras, Dalmatia.
1529. C. hypsclogyra, *Bttgr.* — Java.
1530. C. javana, *Pfr.* — do.
1531. C. ruminiformis, *Alab.* — do.
1532. C. junghuhni, *Phil.* — do.
1533. C. (Medora) oscitans, *Fér.* — Malta.
1534. C. (M.) corrugata, *Chem.* — Jaffa, Palestine.
1535. C. (M.) boissieri, *Charp.* — Elijah's Spring, Mount Carmel, Palestine.
1536. C. (Plicaphora) strangulata, *Fér.* — Dog River, Lebanon, Syria.

Fam. Partulidae.

1595. Diplomorpha layardi, *Braz.* — Vaté, New Hebrides.
1596. D. delatouri, *Hartm.* — Aura, do.

Fam. Achatinellidae.

1537. Achatinella (Newcombia) physa, *Newc.* — Hawaii, Sandwich Islands.
1538. A. (Bulimella) viridans, *Mich.* — Oahn, do.
961. Carelia cochlea, *Reeve.*

Fam. Succineidae.

1309. Succinea putris (*Linné*). — (*Brit. L.* and *F.-W.*, 109; *Perth.*, 57). Perthshire. Cambridge. Abbeville, France.
var. ochracea. — Malham, Yorkshire.
var. intermedia. — Wark, Northumberland.

1310. S. elegans, *Risso*. (*Brit. L.* and *F.-W.*, 110; *Perth.*, 58). Near London.
var. ochracea, *Betta*. Llyn. Curran. Anglesea, Wales.
var. virescens, *Morelet*. St. Mary's Bray, Kent.
1311. S. oblonga, *Drap*. (*Brit. L.* and *F.-W.*, 112; *Perth.*, 59). Perthshire. Gloucester. Schaffhausen, Switzerland.

Class SCAPHOPODA ("Digger-footed").

Fam. Dentaliidae.

911. Dentalium vulgare, *da Costa*. (*British*, 272). South Coast of England. South Brittany.
912. D. elephantinum, *Linné*. Red Sea.
1079. D. octangulatum, *Don*. Japan.
910. Entalis [=Dentalium] entalis (*Linné*). (*British*, 265). Cruden, Aberdeenshire. St. Andrews. Cumbrae, Clyde. Tenby, Wales. Herm, C.I.
1200. E. striolatum, *Stimpson* [=abyssorum]. (*do.* 266). 20 miles west of St. Kilda. [Dredged in 150 fathoms. Dr. Hugh Robert Mill.]

Class PELECYPODA ("Axe-footed." Headless Mollusks, with bivalve shells) [=Lamellibranchiata ("Plate-gilled" Mollusks)].

Fam. Nuculidae.

914. Nucula sulcata, *Brown* [=decussata, *Sow.*]. (*British*, 17). Cumbrae, Clyde.
913. N. nucleus (*Linné*). (*do.* 18). St. Andrews. Granton, Forth. Corrie, Arran. Deerness, Orkney. Tenby, Wales.
441. N. nitida, *Sow*. (*do.* 19). Tenby, Wales.
524. N. tenuis (*Mont.*). (*do.* 21). Cumbrae, Clyde.
916. Nuculana [=Leda] minuta (*Müll.*). (*do.* 25). do. do.
1356. N. tenuis (*Phil.*) [=pygmaea]. (*do.* 26). Shetland.

Fam. Anomiidae.

918.	Anomia ephippium, *Linné.*	(*British*, 46). Deerness. Forth. Clyde. Tenby. Bournemouth. Cornwall. St. Nazaire, France. Lido, Venice. Algiers.
925.	A. patelliformis, *Linné.*	(*British*, 47). Corrie, Arran. Falmouth, Cornwall.
467.	Placuna placenta, *Lam.*	China. [Used in Canton for windows and skylights, instead of glass.]
948.	P. sella, *Gmel.*	do. [The " Saddle-oyster."]

Fam. Arcadae.

928.	Glycimeris [=Pectunculus] glycimerus (*Linné*).	(*British*, 51). Deerness, Orkney. Forth. Falmouth, Cornwall. Herm, Channel Islands.
929.	G. pectiniformis, *Lam.*	Suez.
930.	G. inequalis, *Sow.*	Grand Cayman, W.I.
931.	G. pectinatus, *Lam.*	Suez.
932.	G. violascens, *Lam.* [=cor].	Lido, Venice, and Pozzuoli, Italy. Algiers.
933.	Limopsis multistriata, *Forskal.*	Suez.
919.	Arca tetragona, *Poli.*	(*British*, 54). St. Andrews.
460.	A. noæ, *Linné.*	Lido, Venice. Algiers. Suez. Grand Cayman, W.I.
921.	A. zebra, *Swain.*	Australia.
920.	A. pistachia, *Lam.*	Algiers. Andaman Islands.
925.	A. (Barbatia) lactea, *Linné.*	(*British*, 52). Tenby, Wales. Herm, C.I. Algiers.
1357.	A. (Bathyarca) pectunculoides, *Seacchi.*	Hebrides.
461.	A. (Anomalocardia) grandis, *Brod. and Sow.*	Costa Rica.
922.	A. (A.) tuberculosa, *Sow.*	Suez.
1462.	A. (A.) auriculata, *Lam.*	Indian Ocean.
249.	A. (Scapharca) disparilis, *Reeve.*	Philippine Islands.
954.	A. (Parallelipipedum) tortuosum, *Linné.*	China.

Fam. Mytilidae.

935.	Mytilus edulis, *Linné*.	(*British*, 60). Orkney. Forth. Clyde. Cornwall.
937.	M. viridis, *Linné*.	Algiers. Andaman Islands.
941.	M. (Horomya) variabilis, *Krauss*.	Suez.
936.	Volsella [=Mytilus] modiolus (*Linné*).	(*British*, 61). Orkney. Forth. Clyde.
526.	V. barbata (*Linné*).	(*do*. 62). St. Andrews.
538.	V. adriatica (*Lam*.).	(*do*. 63). Tenby, Wales.
542.	V. phaseolina (*Phil*.).	(*do*. 64). Helford River, Cornwall.
248.	V. metcalfei, *Hanley*.	Philippine Islands.
546.	Modiolaria marmorata (*Forbes*).	(*British*, 66). Deerness, Orkney. Porthcurno, Cornwall.
547.	M. costulata (*Risso*).	(*do*. 67). Porthcurno, Cornwall.
551.	M. discors (*Linné*).	(*do*. 68). Helford River, Cornwall.
458.	Perna elongata, *Chem*.	Central America.
944.	P. plicatula, *Lam*.	Sheep's Head Bay, Coney Island, New York.
946.	Septifer bifurcatus, *Consat*.	California.
949.	Lithodomus [=Lithophaga] dactylus, *Sow*.	Algiers.
950.	L. hanleyanus, *Dkr*.	Suez.

Fam. Aviculidae [=Pteriidae].

459.	Pteria [=Avicula] hirundo (*Linné*).	(*British*, 75). Dredged off Plymouth.
251.	P. nebulosa, *Conrad*.	Sandwich Islands.
953.	P. tarentina, *Lam*.	South Brittany.
951.	Avicula (Meleagrina) margaritifera, *Linné*.	Cook Islands, Australia [The " Mother-of-Pearl " Shell].
552.	Pinna fragilis, *Penn*. [=rudis].	(*British*, 76). Brixham, South Devon. Channel Islands.
250.	P. chemnitzii, *Hanley*.	Philippine Islands.
952.	P. australis.	Australia.
956.	Crenatula [=Atrina] folium, *Gray*.	Suez. Red Sea.

252.	Malleus vulgaris, *Lam.*	China. [The "Hammer Oyster."]
1452.	M. albus, *Chem.*	do.
955.	Vulsella spongiarum, *Lam.*	Suez.
957.	V. crenulata, *Reeve.*	Andaman Islands.

Fam. Ostreidae.

958.	Ostrea edulis, *Linné.*	(*British*, 77). Forth. Falmouth, Cornwall. Whitestable.
258.	O. virginica, *Gmel.*	North America.
960.	O. (Dendostrea) frons, *Linné.*	On roots of Mangrove trees, Africa. [The "Tree Oyster."]

Fam. Pectinidae.

974.	Pecten aurantius, *Sow.*	Mediterranean.
463.	P. (Vola) maximus, *Linné.*	(*British*, 79). Cumbrae, Clyde. Falmouth, Cornwall. Jersey, C.I. Algiers.
256.	P. (V.) modestus, *Reeve.*	Australia.
494.	P. (V.) jacobœus, *Linné.*	Algiers. Suez.
971.	P. (V.) ziczac, *Chem.*	Andaman Islands.
965.	P. (Hinnites) pusio, *Linné.*	(*British*, 80). Orkney. St. Andrews. Forth. Harris. Cornwall. Portrush, Ireland. Pozzuoli, Italy.
964.	P. (Chlamys) varius, *Linné.*	(*do.* 81). Clyde. Orkney. N. Wales. Portrush. Cornwall. Pozzuoli. Algiers. Suez.
447.	P. (C.) islandicus (*Müll.*).	(*do.* 82). Cast up on the shore at Innellan, Clyde (Rev. F. Smith). [Sub-fossil.]
979.	P. (C.) circularis, *Sow.*	California.
254.	P. (C.) senatorius, *Gmel.*	Moluccas. Suez.
255.	P. (C.) tranquebaricus, *Gmel.*	Tranquebar.
962.	P. (C.) asperrimus, *Lam.*	Dredged off East Moncœur, Bass St., 38 fms. [Chall. Exped.]
968.	P. (C.) ornatus, *Lam.*	Grand Cayman, W.I.
973.	P. (C.) irregularis, *Sow.*	Suez.

1201.	P. (C.) pallium, *Linné*.	Ceylon.
462.	P. (Æquipecten) opercularis, *Linné*.	(*British*, 85). Orkney. Forth. Falmouth. Portrush. Algiers.
966.	P. (Peplum) clavatum, *Poli.*, var. septemradiatus, *Müll.*	(*do.* 86). Cumbrae, Clyde.
975.	P. (Palliolum) tigrinus (*Müll.*	(*do.* 87). Deerness, Orkney. St. Andrews. Portrush, Ireland.
1358.	P. (P.) incomparabilis (Risso) [=testae].	(*do.* 88). Lerwick, Shetland.
555.	P. (P.) striatus (*Müll.*).	(*do.* 89). Granton, Forth.
1359.	P. (P.) similis (*Laskey*).	(*do.* 90). Shetland.
969.	P. (P.) plica, *Linné*.	China.
978.	P. (Pseudamussium) latiauratus, *Conr.*, var. monotmevis, *Cpv.*	Seal Beach, California.
464.	Amussium [=Pleuronectia] japonicum, *Gmel.*	Malay Peninsula.
468.	A. pleuronectes, *Linné*.	Japan.

Fam. Limidae.

1360.	Lima elliptica, *Jeffreys*.	(*British*, 94). South Coast of England.
557.	L. subauriculata (*Mont.*).	(*do.* 95). Plymouth. Porthcurno, Cornwall.
976.	L. hians (*Gmel.*).	(*do.* 97). Corrie, Arran [with nest]. Cumbrae, Clyde. South Coast.
257.	L. squamosa, *Lam.*	St. Paul's Bay, Malta. Algiers. Philippine Islands.
977.	L. arcuata, *Sow.*	
1616.	Limea [=Lima] sarsi (*Lovén*).	Loch Fyne.

Fam. Spondylidae.

253.	Spondylus ictericus, *Reeve*	Bermuda.
980.	S. spectrum, *Reeve*.	Indian Ocean.
981.	S. gæderopus, *Linné*.	Mediterranean.
982.	S. americanus, *Lam.*	Coast of Mexico.
983.	S. layardi, *Reeve*.	Syracuse and Pozzuoli, Italy. Algiers.

1513.	S. imperialis, *Chem.*	Pacific Ocean.
1524.	S. aurantius, *Lam.*	do.
1525.	S. sinensis, *Sow.*	China.
465.	Plicatula gibbosa, *Lam.*	
984.	P. ramosa, *Lam.*	Suez.

Fam. Carditidae.

246.	Cardita [=Mytilicardia] antiquata, *Linné.*	Ceylon.
985.	C. caliculata, *Brug.*	Algiers.
1087.	C. floridana, *Conrad.*	West Florida.
986.	Carditella torresi, *Sm.*	West of Cape York, 10 fms. [Chall. Exped.]

Fam. Astartidae.

987.	Astarte sulcata (*da Costa*).	(*British*, 102). Granton, Forth. Cove, Loch Long. Cumbrae, Clyde.
	var. multicostata, *Jeff.*	St. Andrews.
1361.	A. elliptica (*Brown*).	(*British*, 103). Shetland.
988.	A. compressa (*Mont.*).	(*do.* 104). Deerness, Orkney. St. Andrews. Forth. Cove, Loch Long.
	var. striata, *Leach.*	Granton, Forth.
259.	A. borealis, *Forbes.*	Spitzbergen.
606.	Goodallia [=Astarte] triangularis (*Mont.*).	(*British*, 107). Deerness, Orkney. Iona. Helford River, Cornwall.

Fam. Crassatellidae.

989.	Crassatella decipiens, *Reeve.*	New Holland.

Fam. Isocardiidae.

456.	Isocardia [=Bucardia] humana (*Linné*) [=cor, *Lam.*].	(*British*, 108). Cornwall.
457.	I. (Meiocardia) moltkiana, *Chem.*	

Fam. Cyprinidae.

990.	Cyprina islandica (*Linné*).	(*British*, 109). Granton, Forth. Cumbrae, Clyde. Portrush, Ireland.
991.	Trapezium [=Libitina] guinaica, *Lam.*	Sydney Islands.

Fam. Unionidae.

1010.	Margaritana [=Unio] margaritifera (*Linné*).	(*Brit. L.* and *F.-W.*, 184; *Perth.*, 80). Perthshire. [The Fresh-Water Pearl Mussel.]
992.	Unio tumidus, *Retzius.*	(*do.* 181). R. Trent, Oxfordshire. R. Somme, France. R. Rhine, Germany.
993.	U. pictorum (*Linné*).	(*do.* 180). R. Trent. R. Somme. R. Rhine.
994.	U. marginalis, *Lea.*	Calcutta.
995.	U. fruhstorferi, *Dtr.*	
996.	U. (Parrysia) nyassensis, *Lea.*	Lake Nyasa, British Central Africa.
999.	Anodonta cygnea (*Linné*).	(*Brit. L.* and *F.-W.*, 186; *Perth.*, 81). Perthshire. R. Trent. R. Rhine, Germany.
1343.	A. anatina (*Linné*) [=A. cygnea, var. anatina].	(*do.* 186; *var.*). R. Thames, Twickenham.
	var. complanata.	Gumfrieston, near Tenby, Wales.
1002.	A. swinhœi, *Ad.*	
1003.	Pseudodon zollingeri, *Mouss.*	
1000.	Spatha alata, *Lea.*	Lake Nyasa, British Central Africa.
1004.	Pilsbryocandra porrecta.	

Fam. Dreissensidae.

1005.	Dreissensia polymorpha (*Pallas*).	(*Brit. L.* and *F.-W.*, 179; *Perth.*, 79). Perthshire. Manchester. R. Somme, France. R. Rhine, Germany.

Fam. Lucinidae.

660.	Loripes lacteus (*Linné*).	(*British*, 110). Herm, Channel Islands. Arcachon.
1362.	Lucina spinifer (*Mont.*).	(*do.* 112). South Coast of England.
1006.	L. borealis (*Linné*).	(*do.* 113). Deerness, Orkney. Nairn. Cumbrae. Lido, Venice. Pozzuoli. Algiers.
1007.	L. divaricata, *Linné*.	Grand Cayman, W.I.
1008.	L. pennsylvanica, *Linné*.	do. do.
1009.	L. orbicularis, *Linné*.	do. do.
679.	Thyasira [=Axinus] flexuosa (*Mont.*).	(*British*, 114). Granton, Forth. Channel Islands.
729.	Montacuta bidentata (*Mont.*).	(*do.* 123). Helford River, Cornwall.
1617.	M. substriata (*Mont.*).	(*do.* 122). Shetland.
1363.	Tellimya [=Montacuta] ferruginosa (*Mont.*).	(*do.* 127). Shetland.
730.	Diplodonta rotundata (*Mont.*).	(*do.* 129). Bantry, Ireland.
446.	Corbis fimbriata, *Linné*.	Philippine Islands.

Fam. Kelliellidae.

587.	Turtonia [=Cyamium] minuta (*Fabr.*).	(*British*, 100). Tenby, Wales.

Fam. Leptonidae [=Erycinidae].

739.	Kellia suborbicularis (*Mont.*).	(*British*, 130). Tenby, Wales. Herm, Channel Islands. Portrush, Ireland.
778.	Lasæa rubra (*Mont.*).	(*do.* 131). Deerness, Orkney. Tenby, Wales. Helford River, Cornwall.
1618.	Lepton nitidum, *Turt.*	(*do.* 134). Firth of Forth.

Fam. Galeommidae.

1364.	Galeomma turtoni, *Sow.*	(*British*, 139). Channel Islands.
1650.	Ephippodonta lunata, *Tate.*	South Australia.

Fam. Cyrenidae.

1012.	Cyrena zeylandica, *Lam.*	Ceylon. Andaman Islands.
1011.	Corbicula fluminalis, *Müll.*	Ismalia.
1014.	C. sub-radiata, *Phil.*	do.
1013.	C. (Batissa) triquetra, *Desh.*	
1015.	Sphaerium [=Cyclas] rivicola, *Leach.*	(*Brit. L.* and *F.-W.*, 190). Cambridge. R. Somme, France. R. Rhine, Germany.
1016.	S. corneum (*Linné*).	(*do.* 191; *Perth.*, 82). Perthshire. Croydon. R. Somme.
	var. scaldiana, *Normand.*	Birmingham.
1344.	S. lacustre (*Müll.*).	(*Brit. L.* and *F.-W.*, 193; *Perth.*, 83). Perthshire. Manchester.
1355.	S. pallidum, *Gray* [=ovale, *Britt. Auett.*].	(*do.* 194). Near London.
1018.	Pisidium amnicum (*Müll.*).	(*Brit. L.* and *F.-W.*, 196; *Perth.*, 84). Perthshire. Croydon.
1345.	P. casertanum (*Poli*).	(*do.* 198; *do.* 85). do.
1019.	P. pusillum (*Gmel.*) [=fontinale, *Drap.*].	(*do.* 201). Near London.
	var. cinereum, *Alder.*	Manchester.
	var. grandis, *Adams.*	do.
1346.	P. henslowianum (*Sheppard*).	(*Brit. L.* and *F.-W.*, 205). Near London.
1347.	P. hibernicum, *Westl.*	(*do.* 209; *Perth.*, 86). Perthshire.
1348.	P. lilljeborgi, *Clessin.*	(*do.* 208; *do.* 87). do.
1349.	P. milium, *Held.* [=roseum, *Scholtz.*].	(*do.* 202; *do.* 88). do.
1350.	P. nitidum, *Jenyns.*	(*do.* 199; *do.* 89). do.
	var. globosum, *Adams.*	Manchester.
1351.	P. obtusale, *Jenyns.*	(*Brit. L.* and *F.-W.*, 210; *Perth.*, 90). Perthshire. Strathglass, Inverness-shire.
1352.	P. personatum, *Malm.*	(*do.* 200; *do.* 91). do. Colvend, Kirkcudbrightshire.
1353.	P. pulchellum, *Jenyns.*	(*do.* 203; *do.* 92). do.
1354.	P. subtruncatum, *Malm.* [=fontinale, *Jeffr.*].	(*do.* 204; *do.* 93). do.

Fam. Tellinidae.

813.	Gastrana fragilis (*Linné*).	(*British*, 147). Durgan, Helford River, Cornwall [Dredged, 7 fms.].
1034.	Tellina inflata, *Chem.*	Suez.
437.	T. squalida, *Pult.*	(*British*, 150). Helford River. Herm, C.I. Lido, Venice.
1021.	T. donacina, *Linné.*	(*do.* 151). St. Andrews. Bantry, Ireland.
820.	T. pucilla, *Phil.*	(*do.* 152). Deerness, Orkney. Helford River, Cornwall.
436.	T. (Angulus) tenuis, *Da Costa.*	(*do.* 154). Deerness. Hebrides. St. Andrews. Portobello, Forth. Lido, Venice.
1022.	T. (A.) fabula, *Gron.*	(*do.* 155). St. Andrews. Portobello. Cumbrae. Tenby. Scheveningen, Holland. Pozzuoli, Italy.
1024.	T. (A.) incarnata, *Linné.*	Algiers.
1020.	T. (Arcopagia) crassa (*Gmel.*).	(*British*, 149). Corrie, Arran. Forth. Falmouth. Channel Islands.
1030.	T. (A.) fausta, *Donov.*	West Indies.
236.	T. (A.) remies, *Linné.*	Australia.
438.	T. (Pseudarcopagia) lingua-felis, *Linné.*	India.
233.	T. (Tellinella) jubar, *Hanley.*	Swan River.
234.	T. (T.) vulsella, *Chem.*	Borneo.
235.	T. (T.) staurella, *Lam.*	Philippine Islands.
1103.	T. (T.) virgata, *Linné.*	Fiji Islands.
1035.	T. (T.) rostrata, *Linné.*	Grand Cayman, W.I.
435.	T. (Liotellina) radiata, *Linné.*	Philippine Islands. Grand Cayman, W.I.
1017.	T. (Tellinides) rosea, *Spengler.*	Cape of Good Hope.
1032.	T. (T.) timorensis, *Lam.*	Philippine Islands.
1038.	T. (T.) lævigata, *Linné.*	Grand Cayman, W.I.
1039.	T. (Peronæa) planata, *Linné.*	Algiers.
440.	T. (Peronæoderma) prova, *Han.*	
1027.	T. (P.) pisiformis, *Linné.*	

1031.	T. (P.) punicea, *Born.*	West Indies.
439.	T. (Strigella) carnaria, *Linné.*	Fiji Islands.
1060.	T. (Phylloda) foliacea, *Linné.*	Philippine Islands.
1023.	Macoma [=Tellina] balthica (*Linné*).	(*British*, 156). Nairn. Forth. Scheveningen, Holland. Somme Estuary, France. Algiers.

Fam. Scrobiculariidae.

799.	Syndosmya [=Scrobicularia] nitida (*Müll.*).	(*British*, 141). Portrush, Ireland.
782.	S. prismatica (*Müll.*).	(*do.* 140). do. do.
1037.	S. alba (*Wood*).	(*do.* 142). do. do. Loch Long. Portobello, Forth.
806.	S. tenuis (*Mont.*).	(*do.* 143). South Coast of England. South Brittany, France.
1036.	Scrobicularia plana (*da Costa*) [=piperata].	(*do.* 145). St. Andrews. Portobello. Scheveningen, Holland.
1545.	Semele scabra, *Hanley.*	Pacific Ocean.

Fam. Mesodesmatidae.

811.	Ervilia [=Amphidesma] castanea (*Mon.*).	(*British*, 146). Porthcurno, Cornwall.
443.	E. subcancellata, *Smith.*	

Fam. Donacidae.

1041.	Donax (Serrula) vittatus (*da Costa*).	(*British*, 158). Nairn. St. Andrews. Falmouth. Portrush, Ireland. Scheveningen, Holland. Lido, near Venice. Algiers.
826.	D. (S.) variegatus (*Gmel.*) [=politus].	(*do.* 159). Tenby, Wales.
442.	D. (Chion) denticulatus, *Linné.*	West Indies.
1042.	D. (Latona) compressus, *Lam.*	New Hebrides.
237.	D. (Hecuba) scortum, *Linné.*	South Africa.
1040.	Iphegenia [=Capsa] deplorata, *Linné.*	Sawarrowa and Palmerston Islands.

Fam. Mactridae.

1044.	Mactra (Trigonella) stultorum, *Linné.*	(*British*, 160). Nairn. St. Andrews. Portobello. Portrush. Scheveningen. Pozzuoli. Algiers.
1048.	M. (T.) glauca, *Born.*	(*do.* 161). Guernsey, Channel Islands. Lido, near Venice. Algiers.
1050.	M. (T.) olorina, *Phil.*	Suez.
1045.	Spisula [=Mactra] solida (*Linné*).	(*British*, 162). Deerness, Orkney. Hebrides. St. Andrews. Falmouth. Scheveningen.
	var. truncata, *Montagu.*	Portobello, Forth.
1046.	S. elliptica (*Brown*).	(*British*, 163). St. Andrews. Cumbrae, Clyde.
1047.	S. subtruncata (*da Costa*).	(*do.* 164). Troon, and Cumbrae, Clyde.
1051.	Cythœa (Coryalis) rostrata, *Koch.*	Monte Video, 13 fms. [Chall. Exped., 1876].
1548.	Mactrella alata, *Speng.*	Costa Rica.
1109.	Lutraria elliptica, *Lam.*	(*British*, 165). Nairn. Granton, Forth. Cumbrae, Clyde. Falmouth, Cornwall.
828.	L. oblonga (*Chem.*).	(*do.* 166). Falmouth, Cornwall (very large specimens). Channel Islands.

Fam. Veneridae.

1069.	Lucinopsis undata (*Penn.*).	(*British*, 167). Nairn. St. Andrews. Portobello.
1068.	Dosinia [=Venus] exoleta (*Linné*).	(*do.* 168). Carnoustie. Helford River and Falmouth, Cornwall. Portrush, Ireland.
451.	D. lupina, *Linné* [=lincta, *Pult.*].	(*do.* 169). Deerness, Orkney. St. Andrews. Lido, Venice.
228.	D. exasperata, *Phil.*	Philippine Islands.
229.	D. juvenilis, *Lam.*	Manilla.
1062.	Meretrix [=Cytherea =Venus] chione (*Linné*).	(*British*, 170). Durgan, Helford River, Cornwall [dredged, 7 fms., H. Coates]. Falmouth. Rousillon, France.
222.	M. dione, *Linné.*	Central America, West Indies.

219.	M. morphina, *Lam.*	China. [A very variable species.]
220.	M. castanea, *Lam.*	do.
450.	M. maculata, *Linné.*	West Indies.
1387.	M. impudica, *Lam.*	Philippine Islands.
1053.	Venus (Clausinella) fasciata (*da Costa*).	(*British*, 171). Deerness, Orkney. St. Andrews. North Berwick. Cove, Loch Long. Llandudno. Falmouth.
838.	V. (Ventricola) casina, *Linné.*	(*do.* 172). Corrie, Arran. Forth. Falmouth.
1054.	V. (V.) verrucosa, *Linné.*	(*do.* 173). Cumbrae, Clyde. Tenby, Wales. Falmouth, Cornwall. Portrush, Ireland. Algiers.
1052.	V. (Timoclea) ovata, *Penn.*	(*do.* 174). Deerness, Orkney. Cumbrae. Forth. Herm, Channel Islands.
445.	V. (Chamelæa) gallina, *Linné.*	(*do.* 175). Deerness. St. Andrews. Troon. Portobello. Tenby, Wales. Portrush, Ireland. Teignmouth. Lido, near Venice, and Pozzuoli, Italy. Algiers.
217.	V. (Chione) puerpera, *Linné.*	Grand Cayman, W.I. Australia. Andaman Islands. India.
444.	V. (C.) gnidia, *Brod. and Sow.*	Mazatlan.
1055.	V. (C.) listeri, *Gray.*	
1058.	V. (C.) crenifera, *Sow.*	Grand Cayman, W.I.
1059.	V. (Circomphalus) paphia, *Linné.*	West Indies.
1061.	V. (C.) calophylla, *Phil.*	West of Cape York, 3-12 fms. [Chal. Exped.]
1077.	V. (C.) lamellata, *Lam.*	
230.	Tapes rotundata, *Linné.*	East Australia.
1075.	T. orientalis, *Reeve.*	India.
1072.	T. aureus (*Gmel.*).	(*British*, 178). St. Andrews. Forth. Corrie, Arran. Falmouth, Cornwall. Portrush, Ireland.
864.	T. virgineus (*Linné*).	(*do.* 179). Deerness, Orkney. Granton, Forth. Felixtowe. Falmouth [very brightly coloured].

1073.	T. (Cuneus) pullastra (*Mont.*).	(*British*, 180). Deerness. Oban. Cumbrae. Falmouth. Torquay. Herm, C.I.
	var. perforans, *Mont.*	Ramsgate.
1074.	T. (C.) decussatus (*Linné*).	(*British*, 181). Campbeltown, Clyde. Teignmouth. Exemouth. Falmouth.
1082.	T. (C.) geographica, *Chem.*	Algiers.
1076.	T. (Paratapes) textrix, *Chem.*	Mauritius.
448.	Circe plicatina, *Lam.*	Indian Ocean.
1064.	C. (Gouldia) minima (*Mont.*).	(*British*, 182). Deerness, Orkney. Corrie, Arran. Cumbrae, Clyde. South Coast.
225.	C. (Crista) divaricata, *Chem.*	Red Sea.
226.	C. (C.) æquivoca, *Chem.*	Philippine Islands.
1066.	C. (C.) pectinata, *Linné.*	Suez.
1065.	C. (Parmulina) corrugata, *Chem.*	do.
1067.	C. (Circenita) arabica, *Chem.*	do.
227.	C. (Lioconcha) tigrina, *Lam.*	India.
449.	C. (L.) castrensis, *Linné.*	Indian Ocean.
866.	Irus [=Venerupis] irus (*Linné*).	(*British*, 183). Porthcurno, Cornwall.
1071.	I. foliacea, *Desh.*	Algiers.
221.	Callista erycina, *Linné.*	China.
223.	Sunetta [=Meroë] meroë, *Linné.*	Indian Ocean. West Indies.
224.	S. scripta, *Linné.*	do.
1549.	S. magnifica, *Reeve.*	Japan.

Fam. Petricolidae.

1550.	Petricola pholadiformis, *Lam.*	(*British*, 184). [Doubtful British species. Introduced with ballast.]

Fam. Cardiidae.

1644.	Cardium pseudolima, *Lam.*	Suez.
868.	C. (Cerastoderma) exiguum, *Gmel.*	(*British*, 189). Durgan, Helford River, Cornwall.
869.	C. (C.) fasciatum, *Mont.*	(*do.* 190). do. do. Deerness. Granton. Tenby. Portrush.
879.	C. (C.) nodosum, *Turton.*	(*do.* 191). do. do. Jersey, Channel Islands.
1088.	C. (C.) edule, *Linné.*	(*do.* 192). Nairn. Forth. Falmouth. Scheveningen, Holland. Lido, near Venice. Algiers.
1091.	C. (C.) latum, *Born.*	Philippine Islands.
1089.	C. (Isocardia) echinatum, *Linné.*	(*British*, 186). Granton, Forth. Cumbrae, Clyde. Torquay.
867.	C. (I.) tuberculatum, *Linné.*	(*do.* 187). Brixham, Devon. Falmouth, Cornwall. Pozzuoli, Italy. Algiers.
1365.	C. (I.) aculeatum, *Linné.*	(*do.* 185). Devon.
1090.	C. (I.) consors, *Brod. and Sow.*	British Columbia.
238.	C. ((Trachycardium) assimile, *Reeve.*	Zanzibar.
239.	C. (T.) rugosum, *Lam.*	do.
240.	C. (T.) fimbriatum, *Wood.*	China.
452.	C. (T.) muricatum, *Linné.*	West Indies.
1645.	C. (Tropidocardium) costatum, *Linné.*	Pacific Ocean.
1095.	Laevicardium [=Cardium] norvegicum (*Spengler*).	(*British*, 194). Cumbrae, Clyde. Tenby, Wales. Falmouth and Helford River, Cornwall.
434.	L. serratum, *Chem.*	Bermudas.
1092.	L. lyratum, *Sow.*	Fiji Islands.
1096.	L. lævigatum, *Linné.*	Grand Cayman, West Indies.
455.	Hemicardium (Lunulicardia) retusum, *Linné.*	Suez.
1094.	H. (L.) auricula, *Forsk.*	India.
1097.	H. (Fragum) medium, *Linné.*	Grand Cayman, W.I.
242.	H. (F.) hemicardium, *Linné.*	Gulf of Zebu.
241.	H. (F.) unedo, *Linné.*	Philippine Islands.

Fam. Tridacnidae [=Chametrachæidae].

244.	Tridacna [=Cametrachæa] elongata, *Lam.*	Pacific Islands.
245.	T. squamosa, *Lam.*	Ambonina.
493.	T. crocea, *Lam.*	Pacific Islands.
945.	T. gigas, *Linné.*	Indian Ocean. [The "Giant Clam," the largest bivalve shell. Found in coral reefs. Sometimes used as baptismal fonts.]
243.	Hippopus maculatus, *Lam.* [=equinus, *Meuschen*].	do.

Fam. Chamidae.

466.	Chama exogyra, *Conr.*	California.
1093.	C. foliacea, *Quoy.*	
1098.	C. cornucopia.	Suez.
1099.	C. rüppellii, *Reeve.*	do.

Fam. Garidae [=Psammobiidae].

1102.	Gari [=Psammobia] tellinella, *Lam.*	(*British*, 195). Deerness, Orkney. Forth. Tenby, Wales. Falmouth and Helford River, Cornwall.
890.	G. costulata, *Turton.*	(*do.* 196). Durgan, Helford River, Cornwall. Dredged, 7 fms.
1100.	G. ferröensis (*Chem.*).	(*do.* 197). Nairn. St. Andrews. Llandudno, North Wales. Teignmouth. Falmouth.
1101.	G. (Psamocola) depressa, *Penn.* [=vespertina].	(*do.* 198). Herm and Jersey, Channel Islands.
1104.	Soletellina [=Hiatula] diphos, *Linné.*	India.
231.	S. (Psammotæa) violacea, *Lam.*	Ceylon.
232.	S. (P.) bipartita, *Phil.*	Manilla.
1080.	Sanguinolaria sanguinolenta, *Chem.*	Suez.
1081.	S. purpurea, *Desh.*	do.
1105.	Asaphis deflorata, *Linné.*	New Hebrides.

Fam. Myidae.

1106. Mya arenaria, *Linné*. (*British*, 199). Portobello, Forth. Innellan, Clyde.
1107. M. truncata, *Linné*. (*do.* 200). Granton, Forth. Innellan, Clyde.
893. Sphenia [=Mya] binghami, *Turton*. (*do.* 201). Granton, Forth. Tenby, Wales.
1108. Corbula gibba (*Olivi*). (*do.* 202). Granton, Forth. Tenby, Wales. Loch Long.

Fam. Solenidae.

901. Solecurtus scopula (*Turton*) [=candidus]. (*British*, 203). Herm, Channel Islands.
1366. S. antiquates (*Pult.*). (*do.* 204). Fowey, Cornwall.
1110. S. strigillatus, *Linné*. Pozzuoli, Italy.
904. Pharus [=Ceratisolen] legumen (*Linné*). Tenby, Wales.
1111. Cultellus [=Solen] pellucidus (*Penn.*). (*British*, 206). St. Andrews. Portobello, Forth.
1115. Solen truncatus, *Wood*. Ceylon.
1114. S. vagina, *Linné*. (*British*, 209). Tenby, Wales.
1112. Ensis [=Solen] ensis (*Linné*). (*British*, 207). Portobello, Forth. Oban. Innellan, Clyde.
1113. E. siliqua (*Linné*). (*do.* 208). Portobello, Forth. Cruden, Aberdeenshire. Cumbrae, Clyde.

247. Siliqua [=Machaera] radiata, *Linné*. Colombo. Ceylon. Moluccas.

Fam. Saxicavidae.

917. Panopea [=Saxicava] norvegica (*Spengler*). (*British*, 211). Dogger Bank.
1116. Saxicava rugosa (*Linné*). (*do.* 212). Deerness, Orkney. Granton, Forth. Innellan, Clyde. Ayr.

1367. S. arctica (*Linné*). (*do.* 213). South Coast of England.

Fam. Gastrochænidae.

1646. Gastrochæna dubia (*Penn.*). (*British*, 214). Tenby.

Fam. Pholadidae.

1117.	Pholas dactylus, *Linné*.	(*British*, 215). Brighton. Falmouth, Cornwall.
1118.	Barnea [=Pholas] candida (*Linné*).	(*do.* 216). Granton, Forth. Felixtowe, Suffolk.
923.	B. parva (*Penn.*).	(*do.* 217). Teignmouth.
1119.	Zirphæa [=Pholas] crispata, *Linné*.	(*do.* 218). St. Andrews. Granton and Burntisland, Forth.
1368.	Pholadidea loscombiana, *Goodall* [=papyracea].	(*do.* 220). South Devon.
1120.	Martesia striata, *Linné*.	(*do.* 219). Arafar Sea. [Chall. Exped.] (Not truly British. Introduced with ballast.)
1647.	Xylophaga dorsalis (*Turt.*).	(*do.* 221). Forth, near Bass Rock.

Fam. Teredinidae.

924.	Teredo norvegica, *Spengler*.	(*British*, 222). Portland, Hants. Falmouth, Cornwall.
1369.	T. navalis, *Linné*.	(*do.* 223). South Coast of England).
1370.	T. megatora, *Hanley*.	(*do.* 225). South Devon.
1371.	T. malleolus, *Turton*.	(*do.* 226). do.
1372.	T. fimbriata, *Jeffreys* [=palmulata].	(*do.* 228). South Coast of England.

Fam. Pandoridae.

1121.	Pandora inæquivalvis (*Linné*).	(*British*, 234). Jersey and Guernsey, Channel Islands.
1648.	P. trilineata, *Say*.	U.S.A., 25 fathoms.

Fam. Chamostreidae.

1649.	Chamostrea albida, *Lam*.	Port Lincoln, South Australia.

Fam. Anatinidae.

1122.	Cochlodesma [=Thracia] praetenue (*Pult.*).	(*British*, 238). Cumbrae, Clyde. Torquay.
926.	Thracia fragilis, *Penn.* [=papyracea].	(*do.* 239). Granton, Forth. South Coast of England.
1373.	T. pubescens (*Pult.*).	(*do.* 240). South Devon.
1123.	T. convexa (*W. Wood*).	(*do.* 241). St. Andrews.
927.	T. distorta (*Mont.*).	(*do.* 242). Ayr. South Devon.

Fam. Clavagellidae.

718. Brechites [=Aspergillum) javanus, *Lam.* — Java. [Mud-borer. Shell continued by a tube, ending in a " rose."]

Fam. Cuspidariidae.

1577. Cuspidaria [=Neæra] costellata (*Desh.*). — (*British*, 249). Loch Fyne, Clyde.
1578. C. cuspidata (*Olivi*). — (*do.* 250). Isle of Skye.

Phylum **BRACHIOPODA** (" Arm-footed," shell-bearing, marine Invertebrates).

Order **INARTICULATA** (Shell not hinged).

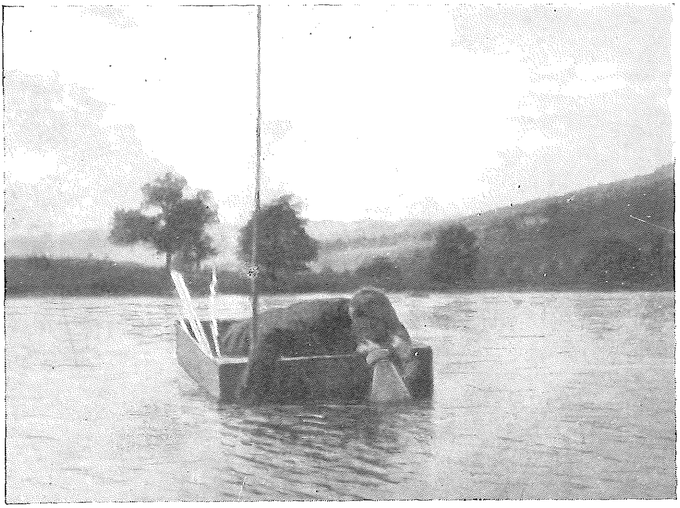
Fam. Craniidae.

939. Crania anomala (*Müll.*). — (*British Brach.*, 1). Corrie, Arran.

Order **ARTICULATA** (Shell hinged).

Fam. Terebratulidae.

1485. Macandrevia [=Terebratula] cranium (*Müll.*). — (*British Brach.*, 2). Faroe Channel, Shetland.
940. Terebratulina [=Terebratula] caput-serpentis (*Linné*). — (*do.* 4). Oban. Cumbrae, Clyde. [Dredged, Dr. David Robertson.]
1487. Dallina septigera (*Lovén*). — (*do.* 5). Shetland. 260 fms.

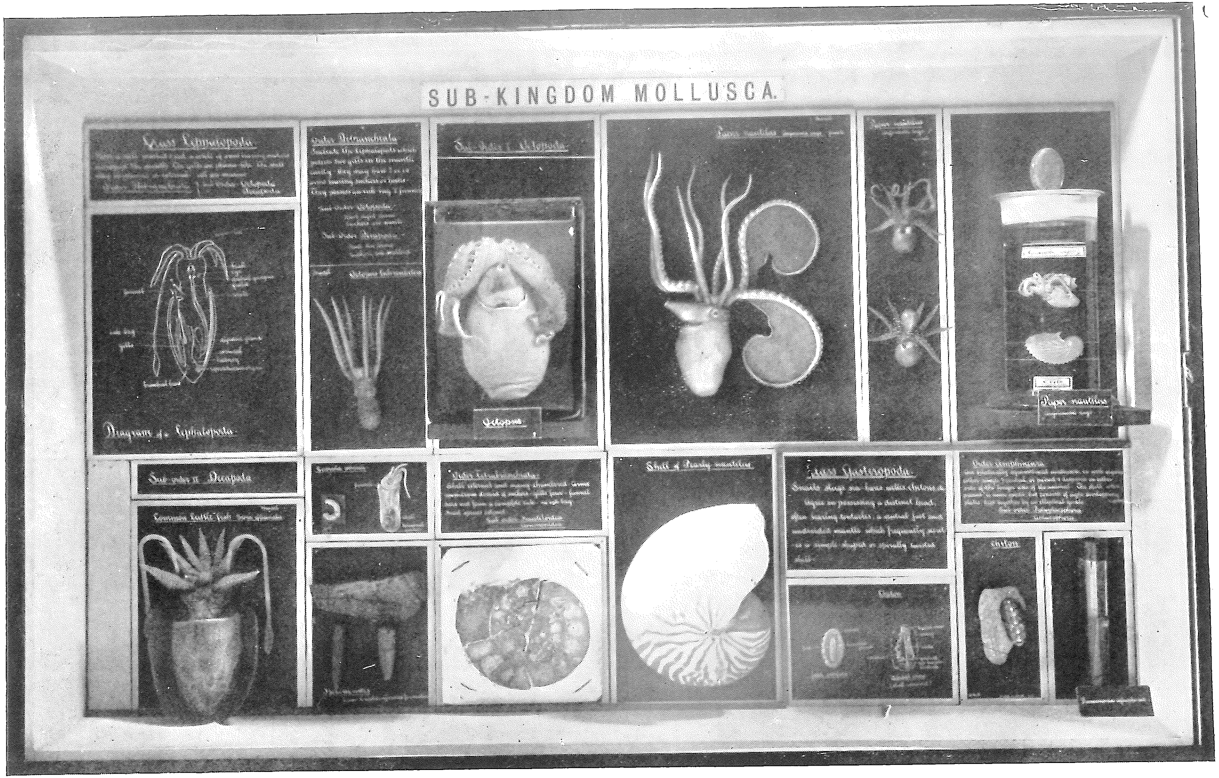


[*Photo.*, *J. Ritchie.*

Plate 5.—Fishing for Pearl Mussels in the Tay at Logierait—Old Style.

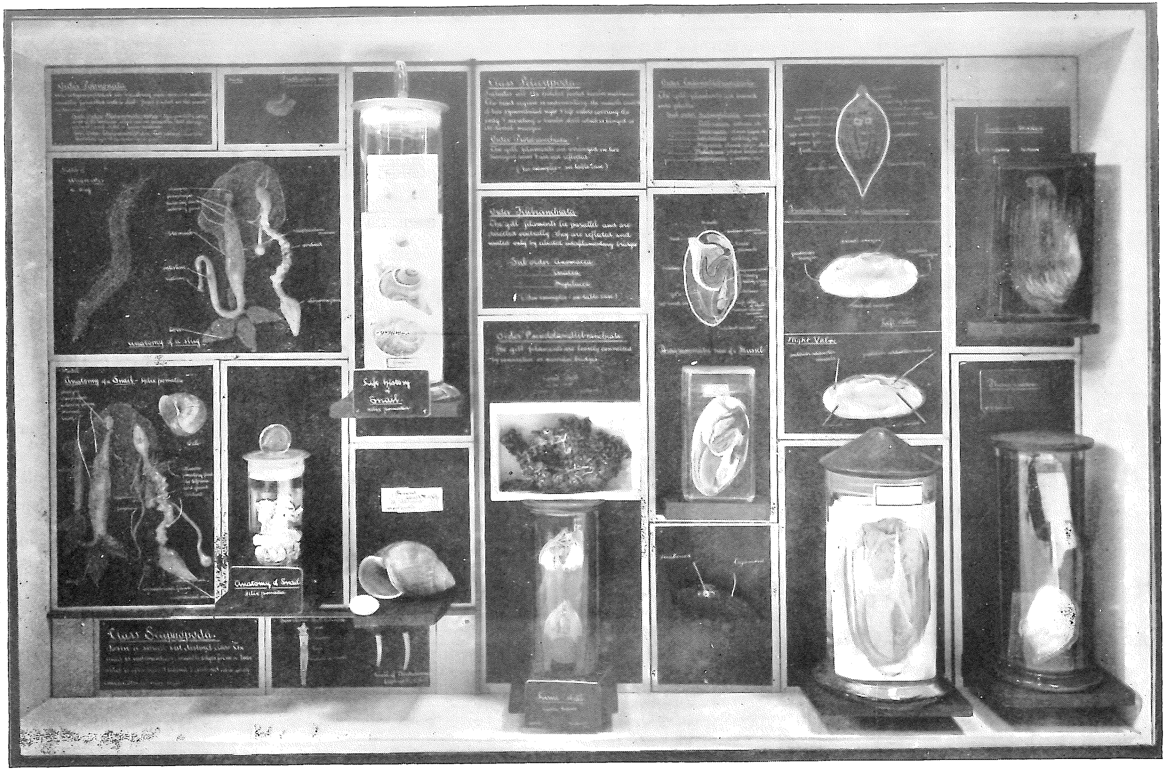
[*Photo.*, *J. Ritchie.*

Plate 6.—Fishing for Pearl Mussels in the Tay at Perth—New Style—July, 1925.



[Photo., J. Ritchie.

Plate 7.—Case Illustrating the Structure and Development of the Mollusca—(1) Cephalopoda.

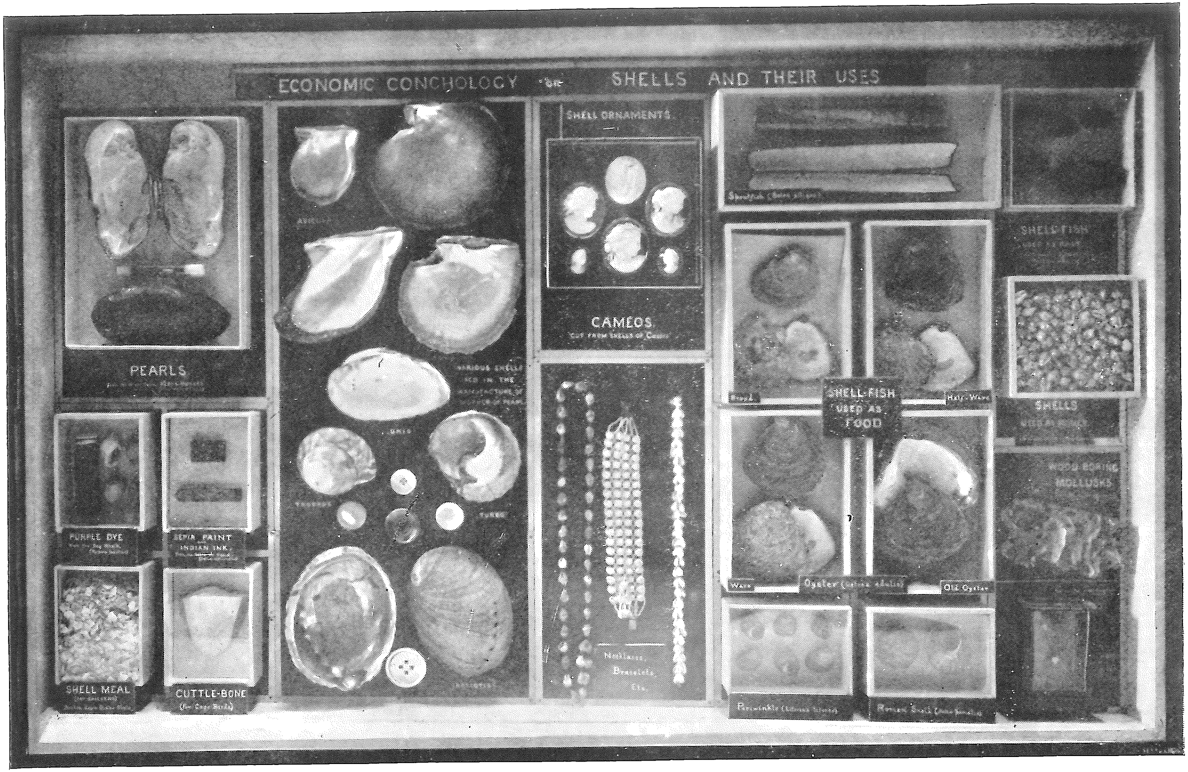


[*Photo.*, *J. Ritchie.*

Plate 8.—Case Illustrating the Structure and Development of the Mollusca—(2) Gasteropoda.

[*Photo.*, *J. Ritchie.*

Plate 9.—Case Illustrating the Structure and Development of the Mollusca—(3) Pelecypoda.



[*Photo.*, *J. Ritchie.*

Plate 10.—Case Illustrating Economic Conchology. Shells and their Uses.

VI.—*Museum Notes by John Ritchie, F.R.A.I., Curator.*

(Taken as read, 13th February, 1925.)

Since the last notes of specimens appeared in 1920, the following notes may not be without interest :—

MAMMALS.

The Wild Cat (*Felis sylvestris grampia*) seems to be on the increase throughout the County. I have seen several specimens from the Aberfeldy district. Another specimen was killed in the Crieff district after attacking a man. A very fine male specimen was presented to the Museum collection by Mr. W. H. Cox of Snaigow. It was caught in a trap at the side of a small loch stocked with trout on that estate. For some time remains of trout had been found at the edge of the loch. A trap was set, and the marauder was found to be the specimen now in our collection.

The Lesser Shrew (*Sorex minutus*, L.). Two specimens were sent to the Museum by Mr. M'Intyre of Dalcroy. Both were caught by his cat, which brought them into his house and laid them on the floor. These are the first authentically local specimens we have in our Perthshire collection, and we are glad to receive them.

The Badger (*Meles taxus*). Of this mammal several specimens have been reported through the County. I have seen specimens from Aberfeldy, Balbeggie, Murthly, Delvine and Strathbraan districts.

The Long-eared Bat (*Plecotus auritus*, L.). I have seen quite a number of these at Stobhall Castle, and during Christmas week, 1924, I observed two flying in Tay Street, Perth.

BIRDS.

Capercailzie (*Tetrao urogallus urogallus*, L.). This bird seems to be on the increase.

Bittern (*Botaraus stellaris stellaris*, L.). Two of these have been obtained at Carsebreck, Blackford.

Siskin (*Carduelis spinus*, L.). A specimen was obtained on the South Inch, Perth.

Sandpiper (*Tringa hypoleuca*, L.). A specimen was obtained in Tay Street.

Quail (*Coturnix coturnix,* L.). A male specimen was found dead on the roadside, under telegraph wires, in May, 1924.

Nightjar (*Caprimulgus europæus,* L.). This bird is reported from Corsiehill, Perth, and from Snaigow.

Osprey (*Pandion haliaetus*). This species is reported to have bred last year in the County.

Hen Harrier (*Circus cyaneus*). The carcase of one of these birds was recognised on a gamekeeper's vermin larder in the Logiealmond district. Enquiries were made and the evidence showed that there had been a male, female, nest and eggs, but that they had been destroyed unwittingly.

Buzzard (*Butes butes butes,* L.). There are buzzards in the Killiecrankie district.

Waxwing (*Ampelis garrulus,* L.). Perthshire, in common with the rest of Scotland, had two visitations of these migrants, the first in November, 1921, and the second in January, 1922.

Slavonian Grebe (*Colymbus auritus,* L.). In February, 1922, a pair of these birds was seen on the river along Tay Street.

Red-necked Grebe (*Colymbus griseigena griseigena,* Bodd.). A specimen from Rannoch was sent to the Museum in March, 1922.

Several albino specimens have been seen during the last year or two. Two white Swallows were noted, one of which found its way to the collection, being found dead in September at Balhousie Castle Garden. A white-breasted Robin was found at Corsiehill, and an albino Willow Wren at Dupplin in 1921.

REPTILES.

Adder (*Vipera berus*). Adders have been recorded in several localities. One was found in the house of Mr. Callander, at Huntingtower, and presented to the collection.

Slowworm (*Anguis fragilis*). One specimen of this (a gravid female) was killed on the railway embankment at Dunkeld. It is now in the Museum collection.

Lizard (*Lacerta vivipara*). Specimens of this have been caught at Glengaur, Comrie, and Glen Lyon.

INSECTS.

Quite a large number of both *Sirex gigas* and *S. cyaneus* have been brought to the Museum for identification. The latter species seems to be on the increase. In 1922, some wood infested with larvæ was brought in from the Bridge of Earn district. The larvæ were bred out and proved to be those of *S. cyaneus*. Many of the larvæ were parasitised with the larvæ of an Ichneumon fly identified as *Rhyssa persausoria,* and hitherto associated with the larvæ of *S. gigas*.

The Humming Bird Hawk Moth (*Macroglossa stellatarum,* L.) was reported from Blairgowrie.

Several specimens of the Convolvulus Hawk Moth (*Spinx convoluli,* L.) were sent in from Dunkeld, Pitlochry and Woodside, while one specimen was obtained in the Northern District School in the City.

The Death Head Moth (*Acherontia atropos*) was reported from Scone, and a living specimen was sent in from Rait, Errol. This specimen on being touched gave out a squeaking sound.

During 1923 and 1924 larvae of the Magpie Moth (*Abraxus grossulariata*) did considerable damage to the foliage of berry bushes in the gardens in the Craigie district of Perth. That these larvæ are not without insect enemies is made evident by the fact that a number of the specimens brought to me were infested with the larvæ of an Ichneumon fly.

Following the clearing of the large forest areas of their timber, the Longicorn Beetle (*Acanthocinus ædelis*) has been distributed throughout the country with the cut wood. Specimens have been found among cut timber as near the city as Stanley.

PLANTS.

Lonicera Caprifolium was found by our President in Glenfarg. There is a record of this plant for the same station by A. Craig Christie, in the "Journal of Botany," 1898, p. 275.

Crysanthemum macrophyllum was obtained in the Rynd district.

Hieracium pulmonarioides was found at Kenmore.

Moneses uniflora has been rediscovered in the Scone district.

Habenaria viridis was found in plenty on Inverchroskie Moor, between Pitlochry and Kirkmichael.

Gagea lutea. A patch of a few plants of this species was found in 1922 on the west bank of the Tay, between Blair Atholl and Killiecrankie, and by 1924 plants were distributed over a considerably larger area.

Carex microglochin was discovered on Ben Lawers.

The alga *Batrachospermum moniliforme* was found by our President in a small stream at Logiealmond.

The fungi *Clavaria botrytis* and *C. aurea* were both found on the bank overlooking the Pass of Killiecrankie.

VII.—*Reproductive Processes in Algae.*

By GEORGE F. BATES, B.A., B.Sc.

(Read 13th March, 1925.)

The student of any particular branch of Natural Science, in his search for the specimens with which he is more immediately concerned, frequently comes across other species which may be in many respects quite as interesting. Thus, in collecting Diatoms I have often found other Algae which, by their inherent beauty, abundance, or other characteristics have demanded a share of attention.

It occurred to me, while following out the structure and life-history of some of these species, that it would be possible to arrange a series of selected types in such a way as to illustrate a general advance in complexity and efficiency of that most important of Nature's processes—the reproduction, by each species, of its kind, as it occurs in the world of plants. In this paper I have endeavoured to work out that idea, limiting myself to illustrations drawn from the extensive class of water plants known as Algae. It is not for one moment suggested that the series as arranged represents a direct line of evolution, but rather that each type represents the stage at present reached along its own line. In graphic representation we should not have a series of points along a line, but rather a number of points terminating the branches of a complex system.

We shall begin by considering a type which has more than once rendered itself very conspicuous by covering with a bluish-green felt the inside of the vessel in which material collected from water was being kept pending further examination. The microscope enabled this growth to be identified as a species of Oscillatoria, a member of the lowest division of Algae—the Cyanophyceae, or Blue-Green Algae. The individual plant consists of an unbranched filament, with rounded ends, composed of uniform disc-shaped cells, united by their plane faces. The ends of the filaments oscillate in a characteristic manner, from which feature the name of the plant is derived. Each cell is capable of division in a plane at right angles to the length of the filament, and after division each daughter-cell grows to the normal size before proceeding to divide again. This process if continued would produce filaments of indefinite length, but here and there in the filament cells die and separation takes place at these points, and then new individual filaments are formed.

On the bark of trees, damp wooden fences, old walls in shady situations, etc., we often find a green powdery covering. Many different items may go to make up this layer, but one of the usual components is Pleurococcus vulgaris, one of the Chlorophyceae, or Green Algae. In this species each individual plant consists of a single approximately spherical cell, with a more or less distinct cell-wall, and an irregularly shaped chlorophyll body, or chromatophore, which almost entirely fills the cell, and to which the green colour is due. A little investigation will show, in addition to single cells, groups of two, three, or more. These groups are purely fortuitous, and are due to the fact that each cell is capable of division, and that the daughter cells remain adherent. There is, however, no organic connection, and each cell, whether free or adherent, is an independent unit. In this process of cell-division, we have the only definitely known way in which Pleurococcus reproduces its kind. A little consideration will show that if the process is at all active, a single individual may give rise to immense numbers in a comparatively short space of time—we have, in fact, a very effective means of multiplication.

The important point to which I wish to draw attention in these two cases is that we find no part of the plant body set aside to carry out the process of reproduction. The ordinary cells of the plant, whose primary function is nutritive, can and do, under suitable conditions, take upon themselves the function of reproduction. We have nothing in any way suggestive of a specialised reproductive process, such as we shall meet with in other types; in other words, reproduction is entirely asexual and vegetative.

It is worthy of note at this point that cell-division as illustrated by Pleurococcus appears to be a physiological necessity as well as a means of reproduction. If we consider a sphere gradually increasing in size, as the Protococcus cell during growth, both its volume and its suface area are growing larger. But a slight knowledge of the mathematics of a sphere will show that although the surface area may be *actually* getting bigger, it is, *relatively to the volume,* getting smaller. Now the whole of the nutriment of a one-celled organism like Pleurococcus must be taken in by the surface, and there would appear to be a limit of size beyond which this cannot be effectively done, at which stage the cell must divide, in order to bring about a necessary increase of surface area, relatively to the volume of the cell.

For our next type we may take Haematococcus pluvialis, otherwise known as Sphaerella lacustrus, commonly found in still water. This plant in some ways resembles Pleurococcus, but differs in some important respects. The cell-wall is at some distance from the essential part of the cell, the intervening space being filled with a watery fluid crossed by protoplasmic threads. From one end—the anterior—proceed two delicate hair-like threads, which traverse the envelope and project into the water in which the organism lives. By their rapid vibration the cilia cause the cell to move through the water. This plant also has a resting stage, in which a thick resistant wall is developed and the whole plant is coloured by a red pigment—thus giving rise to the phenomenon of "red snow."

The mode of reproduction is as follows. The contents of the cell divide up to form a number of ciliated daughter-cells, which break through the wall of the parent cell and ultimately develop into Sphaerella plants. Here again we have an asexual method of reproduction, but in the other species of Sphaerella we find that the daughter-cells, which are much more numerous and minute than in S. lacustris, are incapable of further development until they have fused together in pairs. Here we have the essentials of a sexual process—the fusion of two separate cells to form a third, from which a new individual arises. Such cells are termed gametes, and when actively mobile, as in Sphaerella, they are distinguished as planogametes. The act of union is termed conjugation, and the product is a zygote. It will be noted that in this case the gametes are all exactly alike, *i.e.*, there is no distinction of sex, though one of each conjugating pair must be regarded as male and the other as female.

The green masses of fine filmy threads which are commonly found floating in still water frequently belong to the genus Spirogyra, of which several species are abundant. Under the microscope each thread is seen to be made up of cylindrical cells, joined end to end. The chromatophore is in the form of a simple or complex spiral, forming an object of considerable beauty. The cells of each filament pass first through a vegetative stage, in which division and growth occur; but ultimately each cell becomes reproductive. Most commonly, two filaments, lying parallel to each other in the general mass, take part in the process of reproduction. The protoplasm of each cell rounds itself off, and becomes free from the cell wall. Meanwhile each cell puts out a tubular protuberance, which meets a corresponding growth from a cell of the parallel filament: the ends of the tubes are absorbed, and thus a free passage is established between the cells. The rounded protoplasmic bodies from the cells of one filament then pass over and unite with the corresponding bodies within the cells of the other filament. It is clear that we have here something analogous to what takes place in species of Sphaerella. We note, however, that each cell forms one gamete only: the gametes are not ciliated and actively mobile, and conjugation takes place inside the cells of one of the filaments. We have in fact a sexual process, with a rudimentary indication of sexuality—the passive gamete may be regarded as female, and the moving one as male. We may even go further back and speak of male and female cells, or of male and female filaments. This sexuality, however, is not obvious till conjugation is about to take place.

The resulting zygote passes into a resting stage, still contained within the wall of the parent cell, and when circumstances are favourable, develops into a filament like the parent plant.

The differences between Spirogyra and Sphaerella, in their reproductive processes, are all to the advantage of the former, which may therefore be regarded as more highly developed in this respect. Note the greater certainty of the occurrence of conjugation in Spirogyra. Planogametes set free into surrounding water have a smaller chance of meeting their destined partners than aplanogametes enclosed, protected, and guided at every stage. Hence the latter need not be so numerous, and being less numerous may be larger, and being larger may carry a more abundant store of nutriment for the benefit of the next generation.

Before leaving Spirogyra we may observe that in some species the gametes are derived from adjacent cells of the same filament. In that case we must regard the filament as bisexual, its component cells being alternately male and female. In some allied genera the zygote is formed not within the wall of the parent cell, but midway in the connecting tube. In these cases the sexuality is on a par with that shown by the gametes of Sphaerella: the two gametes are identical in appearance and behaviour, and it is impossible to say which is male and which female.

An interesting type which may be referred to at this stage is Ulothrix, another member of the Chlorophyceae. Like Spirogyra, the plant-body is filamentous, but it is attached by one end to stones or rocks under water. The individual cells are cylindrical, and the chromatophore is in the form of a zone or belt in the middle portion of the cell. The interest lies in the fact that Ulothrix has two different modes of reproduction. The first is by means of ciliated daughter-cells—zoospores—comparable to those of Haematococcus. They are formed in the cells of the older portions of the filament, sometimes singly, but usually in twos, fours, or eights. When mature they escape by the rupture of the cell-wall, and are then seen to be pear-shaped naked masses of protoplasm, each with four cilia and a red pigment spot. After a brief period of activity they settle down by the ciliated end on a suitable substratum, and develop into normal Ulothrix filaments. This method of reproduction is clearly asexual.

In another method a much larger number of ciliated cells is produced within the walls of the parent cell. These may number 64 or more from each cell, and differ from zoospores by their smaller size and by the fact that they have only two cilia. After a period of active movement in the water they fuse in pairs. The zygote swims about for a while with its four cilia, but finally settles down and after a period of rest gives rise to a number of zoospores, from which the parent plant is reproduced. The biciliate cells are clearly planogametes, and their conjugation is analogous to what occurs in some species of Sphaerella. Hence we have here a sexual process.

It occasionally happens that gametes of Ulothrix which have failed to conjugate settle down and attempt to develop after the manner of zoospores, but the resulting plants are invariably feeble. This would seem to indicate that the gametes are really specialised zoospores—zoospores in fact which have developed that characteristic which we know as sex. It is difficult to resist speculation on this point. In all higher organisms the sexual reproductive cells

—the germ cells—are very clearly marked off from the rest of the organism, but we have in Ulothrix a hint, so to speak, that after all germ-cells may be only specialised body-cells.

In all the types so far considered, where conjugation takes place, the gametes are identical, illustrating what is known as isogamy—the union of equal gametes. We now pass on to a type which shows a distinct advance, in that the gametes are specialised, and have ceased to resemble each other. Such a type is found in the genus Oedogonium, different species of which show differing degrees of complexity. Like the two preceding types, Oedogonium is a filamentous Alga, growing in still or gently running water, and attached by one extremity. The cells have irregular chromatophores. Quite apart from the interest of its reproductive processes Oedogonium shows a very peculiar mode of growth of its individual cells, which ultimately gives the appearance of a succession of caps at the upper end of the cell. Zoospores are formed as in Ulothrix, but always singly in the parent cell. Each zoospore has, however, a ring of cilia near its smaller end, which is colourless. When its period of activity is completed, the zoospore attaches itself by its narrower, colourless end to a suitable object in the water, and develops into an ordinary filament.

The sexual process is more complicated than in any of our previous types, and differs in different species. In all cases the female gametes are derived singly from the protoplasm of one cell, which increases in size and becomes rounded in shape. The gamete does not escape from the parent cell and has no cilia. When mature, a slit is formed, in some species, in the cell-wall, so that the gamete is exposed at this point, which is called the receptive spot. In the formation of the male gametes, an ordinary cell of the filament is repeatedly divided by transverse walls, and in each compartment two gametes (or sometimes one) are formed, which resemble the zoospores in all points except their smaller size and yellow colour. Further developments depend on the species. The male gamete may directly fuse with the female, entering the cell in which the latter is contained by the slit already mentioned, or penetrating the cell-wall. In other species the gamete, if it may be so called at this stage—the technical name is androspore—settles down on the exterior wall of the cell containing the female gamete, germinates, and produces a root-cell and two or three other cells, each of which give rise to a true male gamete, which ultimately finds a female gamete and fuses with it. In all cases, after this fusion, the resulting cell matures, passes through a resting stage, and on germination gives rise to four zoospores which in turn reproduce the parent plant.

The new points observed in Oedogonium require a new terminology. To begin with, we note that the gametes are different —the males are motile planogametes, the females non-motile aplanogametes. The union of dissimilar gametes is known as anisogamy. A relatively large passive female gamete is known as an oosphere, or egg-cell, and the union of a small active male gamete with a larger passive female is known as fertilisation, as distinct from conjugation, in which the uniting cells are similar. Fertilisation is, on the whole, a more certain process than conjugation, except perhaps as the latter is exhibited by such plants as Spirogyra. If two persons wish to meet each other in a crowd, they are more likely to meet if one remains stationary and the other looks for him, than if they both move about. This certainty, as in the case of Spirogyra, renders possible a reduction in the numbers of the gametes without undue risk of the non-occurrence of fertilisation. In Oedogonium the reduction has reached its limit in the case of the female cells, and almost so in the case of the male cells. Further, a passive cell may be large and thus provide room for a store of nutriment for the benefit of the offspring. Hence Oedogonium marks a distinct advance on Ulothrix. One other point. The filaments of Oedogonium may be monœcious or diœcious, according to the species, that is, the two kinds of gamete may be produced on the same or on different filaments. In the former case the uniting gametes *may* come from different filaments, as these plants tend to grow in considerable masses; in the latter case they *must* be so derived; and we get what is known as cross-fertilisation. It is hardly possible to say wherein the advantage of cross-fertilisation resides, but it is practically certain that it is an advantage, as so many devices are in existence for securing it. It has been suggested that the union of gametes from different individuals increases the possibility of variation, and tends to give rise to more vigorous offspring. An adequate discussion of this subject is impracticable in the time at our disposal, so we leave it with the remark that however beneficial cross-fertilisation may be, some plants manage to do without it, and are indeed specially adapted for self-fertilisation, and yet show no lack of vigour.

For our next illustration we leave the filamentous type of Alga, and go back to the class represented by Sphaerella. Try to imagine a tiny hollow globe of gelatinous material, no bigger than a small pin's head, with several thousand Sphaerella cells embedded therein, connected to one another not only by the intervening jelly, but also by protoplasmic strands, and with all the cilia projecting at the surface. This will give you an adequate idea of Volvox, one of the most beautiful and striking of microscopic objects. Seen under a low power of the microscope, by reflected light, it appears as a green ball, moving majestically (there is no other word) through the water, and revolving like a tiny world, under the impulse produced by the co-ordinated vibrations of the thousands of pairs of cilia. Except at the reproductive stage, the cells are all alike, and we speak of Volvox as a cell-colony. Daughter-colonies, produced by a process about to be described, are commonly seen inside the parent colony. Volvox is frequently regarded as belonging to the animal world, and you will find descriptions of it, not only in botanical text-books, but also in those relating to the sister science of zoology. Leaving this question on one side, however, we may regard Volvox, vegetatively, as a colony, not a fortuitous collection, but a co-ordinated and regulated colony, of Sphaerella-like cells. From the reproductive point of view, however, we have something which shows a very important advance on Sphaerella. Reproductive processes are of two kinds. In the asexual process certain cells of the sphere enlarge, and project into the internal cavity in a flask-like manner. From the protoplasm of these cells large numbers of motile units are developed, which become aggregated into a daughter-colony. This swims about in the interior of the parent until finally set free by the rupture or death and decay of the latter. Several daughter-colonies of different ages and sizes may frequently be seen inside the parent.

The sexual cells or gametes are of two kinds. The female gametes are formed by the enlargement of the protoplasm of what were previously, to all appearance, vegetative cells. When mature they are set free into the interior of the colony. They are formed singly, and are non-motile and non-ciliated. Similarly, the male gametes are formed from the enlarged protoplasm of a vegetative cell. By repeated divisions of this protoplasm the male gametes are formed in immense numbers. They are of an elongated club shape, and before being shed appear in bundles which have been compared to bundles of asparagus. Each gamete has two cilia, situated laterally, and on liberation swims about actively in the interior of the colony. Finally one male gamete fuses with one female gamete, and fertilisation is effected. In some species the male and female gametes are produced by different individuals, and it would appear that in these species the male gamete must penetrate two colony walls before fertilisation occurs.

The sexual process as observed in Volvox presents several points of interest. The female gamete differs from that of Oedogonium chiefly in the fact that it is liberated from its parent cell. It is not, however, at the mercy of any accidental current in the water, but is confined to the interior of the parent colony. As in Oedogonium, we may speak of it as an egg-cell. The male gametes show a further step in the process of reduction in size. In those species of Sphaerella which produce gametes, in Ulothrix and in other species, there is no distinction of size. In Oedogonium the male gametes are considerably smaller than the egg-cells which they fertilise. In Volvox, they are smaller still, and this small size permits of their being produced in relatively large numbers, with a corresponding increase in the probability of fertilisation, as a single male gamete is sufficient to effect this. Small active male gametes of this kind are termed spermatozoids or antherozoids.

The fertilised egg-cell of Volvox, as of other genera, covers itself with a firm cell wall, and goes through a resting stage before giving rise to a new colony.

The last example which I shall discuss at this time is Vaucheria. It is reproductively at about the same level as Volvox, and illustrates the "infinite variety" of Nature in arriving at the same end by different means. Vaucheria is common on the damp soil of flower-pots in greenhouses: some species, however, actually grow in water. Vaucheria is exceptional in several ways. In the first place, it is a member of the order Siphonales, which present the peculiarity of having no internal cell-walls, however large and complicated the plant-body may be, except such as are developed in connection with the reproductive processes. Secondly it is one of the few fresh-water members of that order, which is chiefly composed of marine types. Thirdly, all members of the order except Vaucheria are isogamous, while Vaucheria, as will be seen, is anisogamous. Under the microscope Vaucheria is seen to be in the form of sparingly branched green filaments, which have the appearance of continuous tubes, owing to the absence of internal cell walls. We must not, however, regard the plant as unicellular, for numerous small nuclei are present, each of which may be taken to represent a cell. A plant body of this kind is known as a cœnocyte.

In the formation of zoospores the end of a branch is cut off by a transverse cell-wall, and from the isolated portion of the protoplasm is developed a large oval body with numerous chromatophores, nuclei, and pairs of cilia. The nuclei form a layer near the surface, and each pair of cilia corresponds to a nucleus. Some observers have traced a correspondence between the structure of the zoospore of Vaucheria and that of the Volvox plant. If we allow for the cœnocytic structure of the former the comparison is by no means far-fetched, and would appear to indicate a relationship between the Siphonales and the Volvocaceae. When fully matured the zoospore escapes by the rupture of the cell-wall, swims about for a time, then settles down and develops into a new plant. In the sub-aerial species the necessary film of water must be present and is supplied by the environment.

In the sexual process egg-cells are developed in lateral out-growths from the branches, which are cut off as single cells by a cell-wall. They are developed singly and when mature contain only one nucleus—hence the egg-cell is a real cell, and not a cœnocyte. It is not set free, but the wall of the parent cell becomes elongated into a sort of beak, the end of which is perforated to form a pore.

The male cells are formed in the terminal cell of a curved lateral outgrowth which is developed in close proximity to that producing the egg-cell. A terminal pore is formed through which the matured gametes escape. They resemble closely those of Volvox, and fertilisation is effected by the entrance of a male gamete through the pore of the cell containing the oosphere, and subsequent fusion.

As in other cases, the fertilised egg-cell develops a firm resistant wall and undergoes a period of rest before germinating and giving rise to a new plant.

This appears to be a convenient point at which to stop. To carry out the plan to a further stage would lead us on to more complicated types of sexual reproduction, such as may be observed in many species of red Algae, and these may possibly form the subject of a future communication. The stages observed up to the present may be briefly classified as follows :—

I. Reproduction purely asexual :—
Oscillatoria, Pleurococcus, Sphaerella lacustris.

II. Reproduction sexual, with or without an accompanying asexual method :—

(a) Gametes identical (isogamy) :

(i.) Gametes passive or slightly motile—Spirogyra.

(ii.) Gametes actively motile—Species of Sphaerella, Ulothrix.

(b) Gametes unequal (anisogamy or heterogamy) :

(i.) Male gametes actively motile : female gamete liberated from parent-cell, but not motile—Volvox.

(ii.) Male gametes actively motile : female gamete passive and not liberated from parent-cell—Oedogonium, Vaucheria.

VIII.—*The Development of Freshwater Fisheries.*

By William Malloch, B.Sc.

(Read 3rd April, 1925.)

INTRODUCTORY.

Our Fisheries have afforded at all times a perennial source of considerable interest to the inhabitants of Perthshire, and a great deal of research has been carried out, from time to time, by those in the County interested in salmon fishing. Situated as we are, by the banks of the finest salmon river in the Kingdom, and within easy reach of innumerable lochs and streams, it would be strange indeed if we remained wholly oblivious of the fish life with which our inland waters abound. From Perth Bridge in the summer we may observe the gambols of the fresh-run salmon, and again in the autumn we are privileged to witness the intimacies of the spawning salmon, bent upon important domestic duties. From times immemorial our river has been densely populated with homing salmon, and even to this day the stock is by no means negligible. "Behold the Tiber," the vain Roman cried. Doubtless his uppermost thought was of the succulent feast of Tay salmon which awaited his arrival by the shores of the Tay. Perhaps like Edward I. the Romans included in their impedimenta or stores a very complete set of nets and fishing gear, and no doubt frequent indents were made on the quartermaster's stores for further supplies.

"Centuries before the era of our oldest University our forefathers carried on trade with the kindred peoples of Flanders, Holland, and Normandy; and the hides and wool of our mountains, the salmon of the Dee and Tay, and the herring of our seas, were exchanged against the cloths of Bruges, the wines of Bordeaux and the Rhine, and the table luxuries as well as the ornaments of dress and art."

At the end of the thirteenth century Edward I. overran Scotland, bringing with him his nets and trained bands of fishermen. Many a barrel of Tay salmon must have accompanied the Stone of Destiny on its journey to London. The use of fixed machinery, such as stake nets, for the capture of salmon, seems to have been early practised on some parts of the Scottish coasts. The Monks of Cupar, in the thirteenth century, had a grant of a Yair in the Firth of Tay. This practice fell into desuetude but was afterwards revived in the Firth of Tay in 1797, with disastrous results to the productivity of the river, finally culminating in its prohibition in 1814.

The old Scottish laws afford the earliest instance of a "weekly close season," for in an Act passed about the year 1220 the following provision occurs for maintaining a free passage through cruives or dam dykes:—"It is statute and ordanit be King Alexander, at Perth, on Thursday, before first of Sault Margaret, with consent of the Erles, Barones and Judges of Scotland, that the midst of the water sall be free, in sa mekill that ane swine of three years auld, and weil fed, may turn himself within it, in sic ane manner, that nather his grunzie nor his tail tuich any of the banks of the water. And it is statute that all waters be fre, and that within tham na man sall slay fisch fra the Saturday efter the evin song, or evening prayeirs, untill Monday efter the sone rysing."

Crossing the border we find that the great Institution, the Magna Charta, ordained that "all weirs in the Thames and Medway, and throughout all England, except by the sea coast should be utterly put down." It is true that the main object of this clause was to remove obstacles to the navigation of the rivers, then the principal and almost the only highways, but in 1472 an Act of Edward IV. recites that the clause against kidels or weirs in the great and laudable Magna Charta was made for "the great wealth of all this land, in avoiding the straitness of all rivers, so that ships and boats might have in them their large and free passage, and also in safeguard of all the fry of fish spawned with the same."

In the year 1400—reign of Robert III.—the Scottish Parliament passed an Act relating to Unclean Salmon.

"Chap. 40. Foul Swyne or Corrupted Salmon sould not be sauld.

"It is statute, that gif any man bringes to the market corrupt swyne or salmond to be sauld, they sall be taken be the baillies, and incontinently without question, sal be send to the lipper folke. And gif there be na lipper folke, they sall be destroied aluterlie."

In olden times the bulk of the salmon was salted and packed in barrels for export to the Continent. A small proportion was boiled and pickled in vinegar, and packed in small kits for London. Fish cured in this latter fashion were known by the name of "Newcastle salmon," the process of fishcuring being carried on to a great extent at Newcastle. During the eighteenth century there were two great fishcuring establishments in Perth which gave employment to a large number of coopers, dressers and packers. The principal curing house, that of Messrs. Richardson & Co., had two smacks for conveying the salmon to London, and the vessels brought back cargoes of porter, groceries, and other goods to Perth. In 1785, on the advice of George Dempster, M.P. for Perth District of Borough, ice packing was adopted which entirely superseded the fishcuring industry. Fish were conveyed in fast sailing smacks to London, and the sale of fresh salmon on the London Fish Market was begun.

In 1797, as already stated, the stake net method of fishing was revived by the four brothers Little, who had experience of this method in the Solway. In one season at the Seaside Fishings below Errol, they captured seven thousand salmon in a single net. Extending their operations, they became tacksmen of many other fisheries and an inevitable and rapid decline in the productivity of the river followed. For the ten years preceding the introduction of stake nets, 1788-1797, the Kinfauns Fishings alone produced 87,000 salmon and 17,070 grilse. During the ten years 1801-1810, the produce sank to 46,663 salmon and 16,168 grilse. Rents fell, until in 1812 the rental of all the fisheries of the river proper, only amounted to £5,161. It was evident that drastic action was necessary, and in 1814 the use of stake nets was prohibited in the estuary, down to Drumley Sands at the mouth of the Firth of Tay. The benefit of this decree was apparent at once, and a big increase in stock took place. The returns from Kinfauns Fishings for the ten years 1815-1824, rose to 90,101 salmon and 86,891 grilse. The gross rental of the river advanced to £14,592, nearly treble that of 1812. For the next few years the Tay Fisheries enjoyed great prosperity, but "hard times" were not far off. In 1820 stake net fishing was once more exploited, this time on the sea coast. From 1825 to 1834, great losses were incurred by all the tacksmen of the Tay. The produce of the river showed an alarming decline, and in 1828 the Home-Drummond Bill for the protection of the River Fisheries became law. This Bill was certainly an advance in certain directions on the provisions of former statutes, but unfortunately in order to secure its passage through Parliament, Mr. Home-Drummond had to consent willy-nilly to the extension of the season from 26th August to 14th September. The evils of the curtailment of the close season far outweighed the benefit derived from the remaining provision of the Bill. In 1828 the Tay rental was £14,574: in 1852 it had fallen to £7,973. By agreement, the proprietors in 1853 reverted to the former close time, 26th August, and beneficial results followed. Much, however, remained to be done in the form of protection of the immature salmon or parr. The results of the Stormontfield experiments, initiated in 1853, clearly established that the parr was the progeny of the salmon, and not a separate species, as up to that time had been held. The Act of 1868 followed, giving full protection to parr and smolts, and holds good to-day.

In 1899 the Tay Salmon Fisheries Company was formed for the better control of netting. Its first and perhaps most important change was to voluntarily petition the Secretary of Scotland to alter the closing day of the netting season on the Tay from 26th August to 20th August, a reduction of six days. The sacrifice of six of the most prolific days of the season was undoubtedly a most venturesome speculation, but it is fitting to record that the policy has been justified. The curtailment of netting stations followed, less than one-half of the former stations being worked. An energetic campaign of incessant warfare was initiated against seals, otters, cormorants, goosanders, mergansers and pike. Rewards are paid by the Company for the destruction of all but the last-named, and through time their numbers will be reduced to safe limits. One of the most notable achievements in the investigation of the life-history of the salmon was the smolt marking experiment undertaken by the Company in 1905. Five thousand smolts were marked in May and June of that year at Kinfauns, by means of a fine silver wire inserted in the dorsal fin and twisted in a loop to allow for subsequent growth. This ingenious method of marking the smolts was devised by the late Mr. P. D. Malloch, then Managing Director of the Company, who originated the experiment and personally supervised operations throughout. No recaptures were made that season, and it was not until 1st June, 1906, that the first marked fish was got, a grilse of 2$\frac{15}{16}$ lbs., and now preserved in the Museum. Further captures of marked grilse of from 3 to 10$\frac{1}{2}$ lbs. were made during the summer of 1906. No marked salmon, however, were got that year. In February, 1907, marked small springers were caught, the run continuing until the middle of June. The average weight of these fish was slightly under 10 lbs. In mid-July of the same year, summer fish appeared, and captures were made up to 20th September, the weights varying from 12 to 27 lbs. In 1908 large spring fish from the original 1905 marking were got, the last being caught on 31st March. The weights ran from 13 to $38\frac{1}{2}$ lbs. All of the foregoing fish, from the grilse of nearly 3 lbs. to the large springer of $38\frac{1}{2}$ lbs., were on their first return to the river and had not spawned previously. In the summer of 1909, three notable recaptures were made of fish of $26\frac{1}{2}$ lbs., $28\frac{1}{2}$ lbs., and 36 lbs. These fish were on their second return to the river, having spawned previously and returned to the sea as kelts. No further recaptures of marked fish were made, the stock evidently having become exhausted, or the few survivors escaped capture. The unqualified success of the experiment disposed of many theories, and firmly established the science of scale reading, from which the age and movements of salmon can be accurately computed.

Many experiments in other directions have been carried out on the Tay and elsewhere, but perhaps sufficient has been cited to demonstrate that serious endeavours have been made throughout the ages to protect and improve our Fisheries. But for the intervention of man-made institutions, conveniently camouflaged under the cloak of municipal progress, rural development, and private enterprise, our rivers would still yield the fruitful harvest of former times. It is unfortunate that Scotland labours on under the heavy disability of an Act more than half-a-century old. Indeed, it might be described as little short of a national calamity, but perhaps an enlightened Government, in an inspired moment, may introduce a Bill moulded on the lines of the English Act of 1923.

LIFE-HISTORY AND HABITS OF THE SALMON.

In approaching the subject before us, it is advisable at the outset to discuss briefly the habits of the fish we seek to protect. Without some knowledge of their movements it is manifestly impossible to make adequate provision for improvement or protection. Freshwater fish can be divided into two main groups, migratory and non-migratory. The first-named group is by far the more important as a national asset, and as in most cases its development in no way hinders, but usually assists, the improvement of the latter group, it will suffice to confine our attention to migratory fishes. These consist of salmon, seatrout, and eels. The first stage in the life history of the salmon and seatrout is known as the ova or egg stage. Mature salmon deposit their eggs on certain suitable fords, called redds, in late autumn or early winter. These redds are by no means promiscuously chosen. They are usually shallow, composed of non-shifting gravel, and not subject to being left high and dry during the incubation period. The female fish scoops a trench in the gravel, in which the eggs are deposited and afterwards covered up. A male attends her and fertilises each successive deposit. The process may last from two to six days, during which time a 20 lb. female fish may deposit anything from 16,000 to 20,000 eggs. The period of incubation may take from 90 to 120 days according to the temperature of the water. The ova hatch out in the form of alevins, curiously shaped creatures, to whose frail bodies are attached a large sac called the umbilical sac. This sac contains sufficient nourishment to maintain existence for six to eight weeks. At the end of this period the alevins begin to prospect for natural food and are then termed fry. During the summer they feed freely and grow quickly. During winter, growth is arrested, and the fry remain dormant under stones or holds. At the yearling stage they are called parr, and a further process of growth is recorded. At the end of two years the parr begin to assume the migratory dress, and by the beginning of May they have become silvery smolts, ready to proceed down to sea. By the end of June the smolts have disappeared from the river, and no trace of them is found until the following summer, when a certain proportion may return to the river as grilse, *i.e.,* salmon of a little more than three years old, weighing from 2 lbs. upwards. The balance of the batch of smolts remain in the sea, some returning as small spring fish about four years old, others at later dates as large autumn or large spring fish, and correspondingly older.

At the smolt stage the immature salmon weighs two to three ounces. In one year's life in the sea, it may increase in weight by 6 or 8 lbs., in two year's sojourn, by 15 to 20 lbs., in three years by 30 to 40 lbs., and so on. This rate of growth is little short of remarkable, indicating a plentiful supply of rich food in the sea. It is worthy of remark that the process of building up during the salmon's sojourn in the sea does not cost the country anything in the shape of foodstuffs or protection, and this enormous increase in valuable food supply is delivered to our coasts and rivers virtually free.

The movements of salmon on their approach to our rivers are more or less influenced by climatic conditions. Wind, tide, and temperature have their effect, and in entering the estuary additional factors come into play. One of the most effective barriers to fish in a tidal estuary is the presence of pollution, particularly during dry summer. Nothing short of a heavy spate will induce salmon to penetrate the barrier, and the frequency with which spates occur will determine the success or otherwise of a fishing season. The Tay is a notable example of a tidal estuary contaminated by pollution, in this case from the City of Perth, and only during a wet summer, such as was experienced during 1924, is the catch at all commensurate with the capacity of the river. The presence or absence of a shallow bar at the river mouth has also an effect upon the run of salmon, which have a preference for deep water. Having reached the river, the salmon make their way up to the higher reaches. During early spring they travel slowly, and a touch of frost or of snow water arrests the upward movement. Obstacles which later on in the year are surmounted with ease present serious difficulty, and in many rivers replete with weirs and falls, little progress is made until May. Summer fish, on the other hand, travel quickly and take every advantage of freshets to reach the spawning grounds. It is important, therefore, to note that the presence of barriers in a river constitutes a serious menace to its welfare. The congregating of a large number of fish below a weir or falls for any length of time may result in outbreak of disease and consequent serious loss. In one river which I had occasion to visit, several hundreds of dead fish had to be buried on this account during a particularly dry summer. As already indicated, freshets are invaluable in attracting summer fish into the rivers and in distributing them over the various tributaries and sidestreams. After spawning, a large proportion of the fish die, the mortality amongst males being greatest. The survivors are known as kelts or unclean salmon, unfit for human consumption, and by no means prepossessing in appearance. These kelts fall back to the sea to recuperate, and afterwards make a second return to the river. They are then known in certain districts as bull trout. The bull trout is much inferior to the salmon as a table commodity, its flesh being coarse and white. On rare occasions, salmon have been known to have made three and four sojourns in the sea, but these are quite exceptional.

This then, briefly, is the life-history of the salmon. The important points to note are:—

(1) The initial or parr stage, and the need for protection of the immature salmon from starvation, pollution, and predatory fishes, animals, and birds.

(2) The ascent of the mature salmon on its return, and the effect of weirs, falls, and lack of water on its progress, and its susceptibility to disease.

(3) The importance of a wide distribution of breeding fish throughout the river and its tributaries.

PROVISIONS OF THE ACT OF 1868.

Before proceeding to discuss in detail how such results may be aimed at if not achieved, it would not be out of place to turn for a moment to the provisions of the Salmon Fisheries Act of 1868, particularly to Schedule G.

Para. I. and II. call for a little comment. It is obvious that the greater the flow in the river the better chance there is for the fish to reach and surmount the weir.

III., IV., and V. provide for gratings at (1) the intake to each lade, (2) immediately above the entrance to each mill wheel, and (3) at the lower end of the tail race at its entrance to the main river. In many cases these Bye-Laws are ignored or evaded, and much loss is suffered in permitting salmon and kelts to find their way into the lades.

VI. First para. does not appear to be entirely satisfactory, and the provision of smolt gratings at the intake during the period of downward migration seems advisable.

Second para. The entire success of this Bye-Law lies in the first sentence: the sting is in the tail, and the recommendations contained therein do not, in my opinion, provide a salmon pass capable of affording a free passage for the ascending fish at all times when there is water enough in the river to supply the ladder.

Section VIII. of the Act of 1862—Penalty for causing or allowing poisonous substances to flow into rivers.

This Section is far from adequate and leaves too much latitude for evasion on the part of offenders.

SUGGESTIONS FOR IMPROVEMENT.

In approaching the question of improvements on a river, the first consideration is to ascertain if the river has an attractive outlet to the sea, or if a tributary, to the main river. Little benefit is likely to be derived from extensive improvements higher up if, in the first instance, the salmon are only able with difficulty to find their way into the river. Where shallow bars exist, considerable improvement can be made by confining the river into a narrow channel, by throwing croys across at suitable spots, or by the formation of an entirely fresh channel. In certain cases it may be found impossible to carry out such improvements; objections may be raised by adjoining proprietors, or the cost may prove prohibitive; and other means have to be adopted. Again, it may be found that lack of water in the river during drought prevents salmon collected in the bay from ascending. This form of complaint is particularly prevalent in West Coast rivers. Many of these rivers have an abbreviated run to the sea. The catchment area is usually precipitous and sudden spates of a violent and transitory nature occur. Frequently they do not coincide with the flow of the tide when fish assemble at the river mouth, and the opportunity for an easy run is lost. Many of the rivers proceed from lochs, and unless the rainfall is prolonged, little effect is gained from an ordinary fall of rain. Scringing, or illegal poaching of fish in the bays, is still by no means an unusual occurrence in the West Coast, and it is essential that the opportunities for successful scringing should be as few as possible. The obvious remedy is to construct storage reservoirs or lochs which will permit of control of the river. Spates can then be created at will. They need not be of lengthy duration, and in most cases two hours before and after high tide will be found ample. In similar manner, salmon can be induced from large rivers or lochs into small tributaries.

The main object of river improvements is to ensure that a plentiful stock of fish will be well distributed over the entire length of the river. The productivity of a river depends wholly upon the amount of breeding ground available. It is important, therefore, that no potential spawning ground should be left unoccupied. Where obstacles exist, suitable fish passes should be constructed. In many cases the obstacles consist of natural barriers, such as falls, and only a minute examination will determine whether or not fish passes are feasible. Frequently, however, the barriers consist of weirs and dams, which generally offer less difficulty to successful treatment. There are no formulæ for dealing with fish passes in a stereotyped manner. Each weir or barrier has its own peculiarities and special features. The problem in every case is how best to take full advantage of these features. Certain guiding principles may be noted. The most efficient fish passes are those of the "Black water" type. Such passes permit salmon to swim easily through the pass, and there is no occasion for leaping. The pass takes the form of a channel constructed on an easy gradient, preferably of 1 in 20, and provided with breaks at intervals. The breaks may consist of rows of stones inserted into the floor of the pass, or of dwarf walls provided with gaps. The most important point to be observed is the choice of the intake and outlet. Careful observation of the river at varying heights must be taken, and the sill levels adjusted so as to provide an adequate flow of water when the river is in good order for fish running. The outlet must present a strong attraction to fish, otherwise they might miss the entrance to the pass, and it must also be placed at or adjacent to the point where the fish usually lie. Neglect of these precautions has been responsible in most cases for the comparative failure of many passes. The most economical design is found where the banks permit of a pass being constructed round the end of the obstacle. Little coffer damming and pumping is necessary, and the greater part of the work can be carried out under dry conditions. Floods have less effect on such passes, and the ascent of fish is made easier.

The white water type of pass consists of pools and leaps. In certain cases, particularly in low weirs, this form of pass has been adopted. The majority of English fish passes are of this character. Their disadvantage lies in their unsuitability to cope with the changeable nature of the state of the river. In low water conditions the jumps may become formidable, and in high water the pools become a seething mass of foaming water. Further, excellent opportunities are afforded for poaching, snatching, and sniggering the fish out of the pools, and efficient watching becomes burdensome. In many cases the pass is expensive both in construction and maintenance. It is not a suitable design to adopt in the case of high weirs or falls, since the number of jumps becomes excessive.

Certain provision requires to be made to avoid silting up in the case of passes erected at falls. Many of our rivers bring down an incredible accumulation of gravel and stones during a flood, and it is important that the mouth of the pass should not face directly upstream. A short breakwater or wall erected on the upper side of the pass at the intake will be found to overcome this evil, and the main current of water will sweep the gravel beyond the mouth of the pass.

In addition to the foregoing types of pass, there remains another, which, however, scarcely merits the title of fish pass. It consists in placing a diagonal beam on the downstream face of the weir. This beam has the effect of concentrating the thin sheet of water from the crest of the weir into a narrower and deeper flow. Under certain circumstances, fish are enabled to swim up, as the gradient and consequent force of water is diminished. This form of pass is only applicable to low weirs of easy gradient, and even so it is at best unsatisfactory. In low and high water it is entirely useless.

ARTIFICIAL HATCHING.

In many rivers the amount of spawning ground is very limited owing, perhaps, to the presence of unsurmountable barriers, or to a general lack of suitable spawning fords. In such cases, improvement in yield is still possible by resort to artificial spawning and hatching. It has not been firmly established that artificial methods confer any benefit over the natural process in spite of the losses sustained by the scouring effect of floods and other causes, but, where the spawning ground is almost if not entirely negligible, artificial means may be advantageously introduced. The process of capturing and stripping spawning fish is carried out extensively on some of our northern rivers with a fair measure of success, but it is doubtful if any material benefit is derived where sufficient natural redds are available. The provision of hatcheries and the annual outlays incurred in operating them make the process somewhat expensive, but it is usually possible to obtain a supply of alevins or fry from any of the well known hatcheries, such as the Howietoun Fisheries, Stirling. Stocking by means of fry is quite common in the West Coast, and has resulted in a fair measure of improvement.

POLLUTION.

The effect of pollution on a river is felt in diverse ways. If severe, fish are poisoned outright in large numbers. In other cases the food and plant life upon which the parr find sustenance are seriously depleted, if not destroyed, with consequent loss to the future stock of salmon. Frequently the spawning beds are adversely affected, and the ova fail to hatch out. The more common forms of pollution consist of deleterious materials or liquids from factories, chemical works, bleach works, distilleries, lead mines, sheep dips, town's sewage, tarred roads, paper mills, and flax steeps. All of the above have a detrimental effect upon fish life, and the remedy consists either in removing them entirely from the rivers and streams, or in so treating them that the effluent is entirely innocuous. Reference has already been made to the effect of sewage on the movements of salmon in tidal waters. The cause of the dropping back of the fish under such circumstances can be directly attributed to the deoxygenation of the water.

PROVISIONS FOR CAPTURE.

Having secured an adequate stock of fish in a river, there remains but the method of capturing the surplus not actually required for breeding purposes. The means adopted for this purpose consist of three forms :—

(1) Netting.

(2) Fixed Engines.

(3) Rod and Line.

NETTING.

There are two forms of netting, both of which are extensively used, sweep nets and stake nets. The latter are confined entirely to the coast and need not be discussed. In the case of sweep nets, considerable initial trouble is taken in providing suitable netting spots called shots. Tow paths have to be made, halings or suitable landing places constructed consisting of gravel beaches, and all rocks, boulders and obstructions removed from the bed of the river. In deep waters the removal of holds is by no means a simple matter. Use is made of a Lewis. This consists in jumping a small hole about six inches deep into the boulder, and in inserting into the hole a long rod with a specially prepared end of similar diameter to that of the jumper. Care must be taken not to allow the rod to reach the bottom of the hole. The job is a ticklish one, as frequently on withdrawal of the jumper the hole cannot be found and a fresh hole has to be made. When properly applied, boulders of five tons and upwards can be raised and towed to the bank.

FIXED ENGINES.

The only permissible fixed engine with which I am acquainted is the cruive. This consists of a weir thrown across a river and provided with gaps. The gaps in turn are provided with two hecks or gratings, the lower grating consisting of two halves pointing diagonally upstream and separated by a narrow gap, through which a salmon can just barely pass. As the cruive under normal circumstances passes the entire volume of the river through a narrow opening, the fish are led or attracted to the intake, and on attempting to push through are finally caught fast in the trap. Fortunately this form of fishing dyke is becoming extinct, and doubtless through time will entirely disappear.

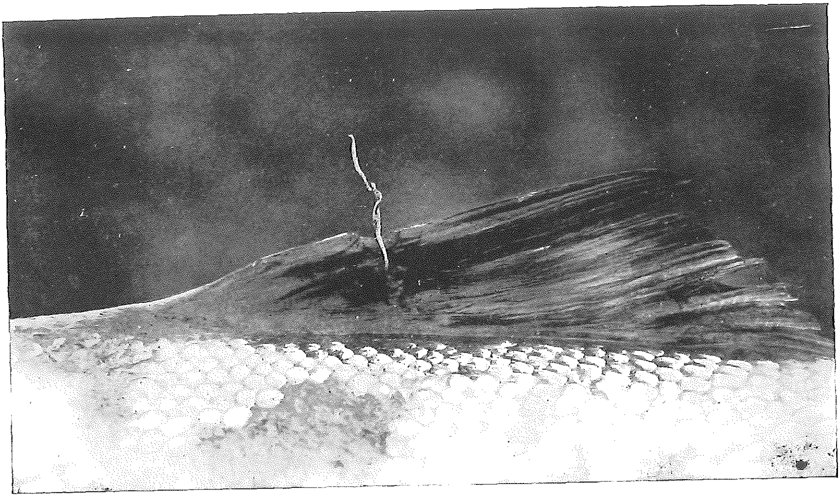
ROD AND LINE.

Much thought and ingenuity has been bestowed on the improvements of rivers from an angling point of view. The creation of pools for holding fish, and of croys and groynes to provide casts has been carried out on most rivers. Each of these function admirably under suitable conditions, but when the river is dead low, something more is required. The only possible means of providing sport under hopeless conditions is by supplementing the natural flow with additional water from an impounding reservoir.

Notable examples of this method are found on the Helmsdale, Thurso, and Grimersta. Sufficient water is stored up to keep these rivers in good fishing ply for lengthy periods, and rarely does the supply fail. The results from these storage dams are little short of remarkable, and it is not surprising that short stretches or beats on these rivers command fabulous rents.

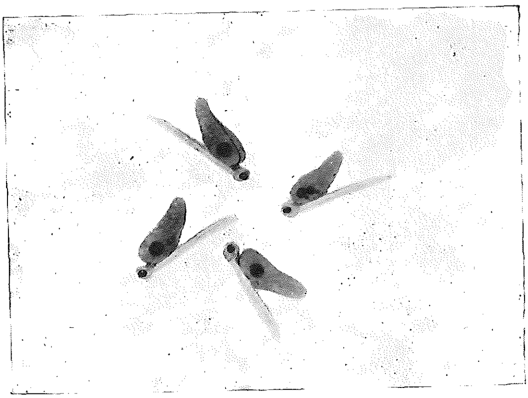
CONCLUSION.

The continued decline of our fisheries is a matter of grave concern to those interested in national welfare. As a valuable source of food supply, a means of employment, an important medium of international trade, and a very pleasant form of recreation, our fisheries are justly entitled to a place in the scheme of national economy. Hitherto, municipalities, local government boards, and company promoters have utterly disregarded fishery interests. Abstraction of invaluable water, creation of impassable barriers, and wholesale pollution of a most virulent kind, have all decimated the fish life on our rivers. Too often and too long our rivers have been treated as a convenient dump for garbage, and a facile channel for refuse and sewage disposal. It is not too much to expect that those responsible for pollution should be charged with its treatment or removal. In the case of abstraction of water, compromise and conciliation of apparently conflicting interests is always possible, provided the opposing parties are prepared to negotiate in an amicable spirit. The development of water supply or water power schemes need not be accompanied by the extinction of fisheries. The fishing interests, on the other hand, can well afford to dispense with the devastating effect of floods, when millions of gallons of water go to waste, water which may be of inestimable value to progressive communities. It is, however, very necessary that "compensation water" (so called), should be delivered to the impoverished streams on a more generous scale than is usually given. Where this is impracticable, and inevitable damage arises, it should be possible to compensate the loss by means of a monetary grant to be applied towards the opening up of fresh spawning ground, and improvement of existing facilities within the district affected, or if need be, in the provision of hatcheries. Much can be accomplished by mutual goodwill. Hostility and suspicion can only end in disaster, and the weaker party, generally the fishery proprietor, goes to the wall. Few but the wealthiest concerns can survive a costly defensive litigation against Provisional Orders and Private Bills promoted by powerful companies. Even a successful opposition may cripple for many years the resources of a prosperous fishery district, and leave it at the mercy of further attacks. Little improvement in our fisheries can be expected until this serious encroachment on the part of outside interests can be checked, and nothing short of a drastic amendment of the present Bye-Laws regarding pollution will remedy the most prolific cause of decline in the productivity of our rivers.



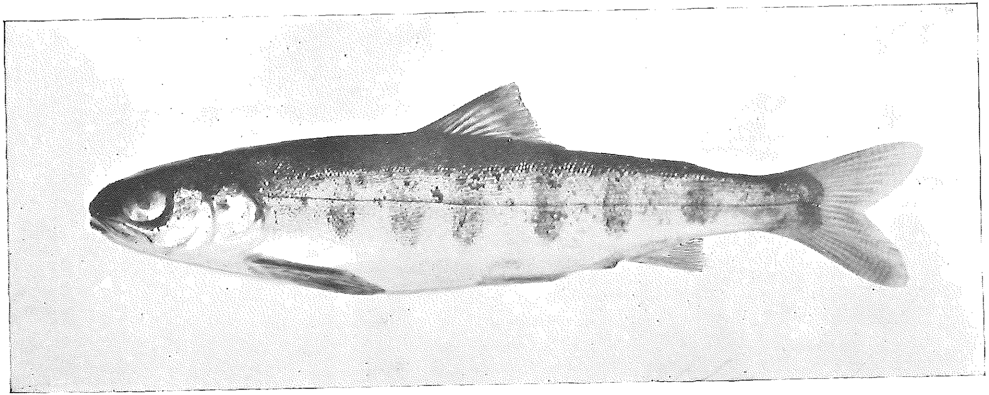
[*Photo. by the late Mr. P. D. Malloch.*

Plate 11.—Mark of First Marked Grilse, 1st June, 1906. 2 lbs. 15 oz.
Marked as Smolt, May, 1905.



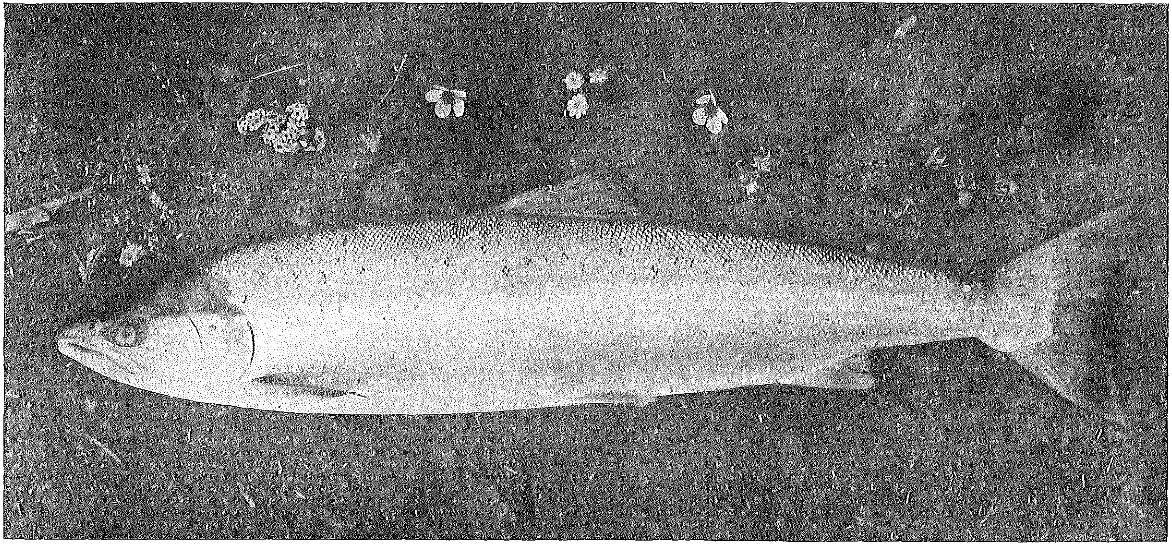
[*Photo. by the late Mr. P. D. Malloch.*

Plate 12.—Alevins.



[*Photo. by the late Mr. P. D. Malloch.*

Plate 13.—Parr, life size, one year old.



[*Photo. by the late Mr. P. D. Malloch.*

Plate 14.—Male Grilse, 4½ lbs., caught 20th June, 1906.

Marked as Smolt, May, 1905. Age, 3½ years.

[*Photo. by the late Mr. P. D. Malloch.*

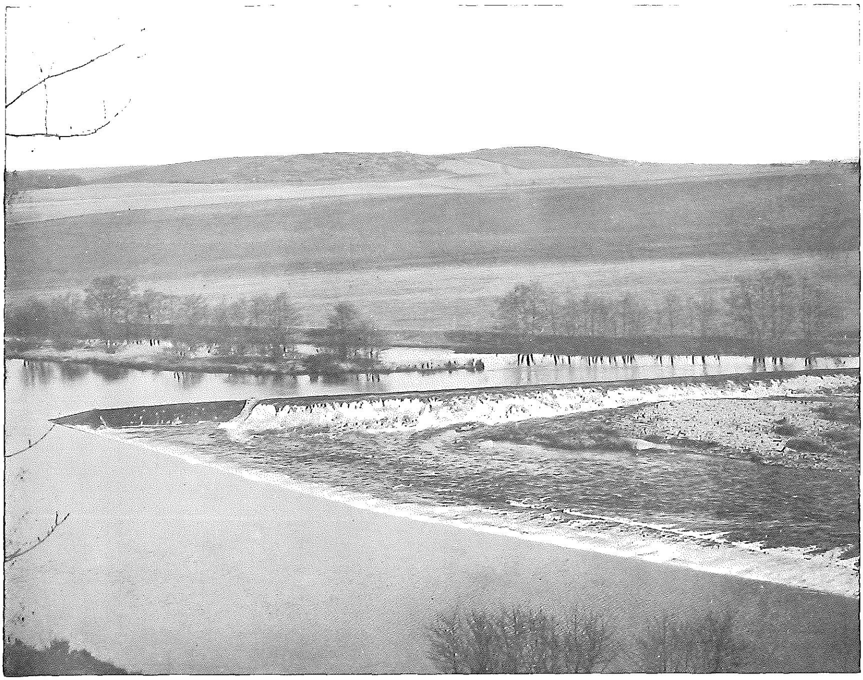
Plate 15.—Small Spring Salmon, $8\frac{1}{2}$ lbs., 6th April, 1907.

Marked as Smolt, May, 1905. Age, four years.

[*Photo. by the late Mr. P. D. Malloch.*

Plate 16.—Large Spring Salmon, 35 lbs. Caught at Almondmouth, 31st March, 1908.

Marked as Smolt, May, 1905. Age, five years, the Fish having spent nearly three years in the Sea.



[*Photo. by the late Mr. P. D. Malloch*.

Plate 17.—Morphie Weir, River Esk.

A formidable barrier to the ascent of Spring Salmon.

Reproductive Processes in Algae.—Part 2.

Presidential Address.

By George Bates, B.A., B.Sc.

(Read 12th March, 1926.)

On the occasion of our last Annual Meeting I had the pleasure of addressing you on the subject of Reproductive processes in Algae, and endeavoured to show you that it was possible to arrange a series of types of Algae in such a way as to demonstrate a progressive increase in the complexity of their sexual reproductive methods.

This evening I propose to continue the same subject and to describe a further series of types, but, before proceeding to do so, it may be as well for us to spend a few minutes in discussing what Algae really are. To begin with, Algae are all inhabitants of water—they are universally distributed in all bodies of water from the sea to the tiniest pools, or even to places which are only damp. Then it is only in a comparatively small number of species that we meet with anything like differentiation of the plant body into separate organs, such as stem, root, and leaf. Some of the larger seaweeds do exhibit a certain amount of differentiation, but the vast majority of Algae consist of single cells, undifferentiated cell-masses, layers one cell thick, or filaments. In size Algae vary from single cells of microscopic dimensions to the giant kelp of the Pacific, which is stated to have fronds sometimes nine hundred feet in length. Living as they do in water by which they are supported, Algae have no need of lignified tissues, and such are accordingly absent. With regard to their mode of nutrition, Algae are invariably holophytic, that is, by virtue of the chlorophyll they contain they are able to build up their own organic material from simple mineral substances, water, oxygen, and carbon dioxide derived from the environment. In this respect they differ markedly from Fungi, although they have many other points of relationship with that class of plants.

It is, however, in their reproductive organs that Algae are most clearly marked off from all the divisions of plants except Fungi. In my preceding paper I had frequent occasion to refer to the female reproductive cell—the ovum, or egg-cell. In all classes of plants from the mosses and liverworts upwards, the egg-cell is enclosed in a flash-shape structure known as an archegonium. This is most typically so in mosses and ferns and their allies; when we come to gymnosperms and flowering plants the archegonium is often reduced almost to a point at which it ceases to be recognisable as such.

In Algae, however (and Fungi), the egg-cell is never enclosed in an archegonium, and this constitutes a distinctive mark of these classes.

As I shall have occasion to refer to the Sub-Classes of Algae, it may be noted that these are four in number, distinguished in each case by a characteristic colour:—

1. Cyanophyceae—Blue-green Algae.
2. Chlorophyceae—Green Algae.
3. Phaeophyceae—Brown Algae.
4. Rhodophyceae—Red Algae.

When the colour is other than green, the reason is that the green chlorophyll is more or less completely disguised by the presence of some other pigment. Colour, in itself, is not a character of any great importance, but it so happens in the case of Algae that the presence or absence of additional pigment is correlated with other characters, and thus, in this particular case, affords a ready method of classification.

The types discussed in my former paper, with the exception of Oscillatoria, belong to the green Algae, and we may at this stage consider briefly a type which has been variously regarded as the highest of the green Algae, or as a sort of connecting link between the Algae and the Bryophyta, a higher group which includes mosses and liverworts. However this may be, it is evident that the type in question, Chara, is a much more highly differentiated plant than any we have yet considered. We are not concerned with its vegetative structure, though this is full of interest. The plant as a whole bears some superficial resemblance to a horsetail, but is softer and more delicate. Except when growing in water which is free from lime compounds, as in our Highland lochs, the plant becomes covered with an incrustation of calcium carbonate, hence the popular name "stonewort."

The reproductive organs are of two kinds, growing, in the common species, adjacent to one another on the fertile branches.

The male organ, or antheridium, is globular in shape; green when young, reddish or orange-coloured when mature. Its external wall consists of eight thin cells, joined by their infolded margins. Each cell is termed a "shield," and bears internally a projecting cell of cylindrical shape, termed the manubrium. The manubrium in turn bears a head-cell, and each of these six smaller cells, and each of these again six slender filaments, each composed of one to two hundred flattened disc-shaped cells. Each of these cells gives rise to a male gamete, consisting of a pear-shaped speck of protoplasm with two cilia. A little calculation will show that each antheridium may contain nearly 40,000 male gametes, which, when the ripe antheridium bursts, escape into the water and swim about by means of their cilia.

The female organ consists of an egg-cell, closely invested by an envelope consisting of five spirally twisted cells, which project at the summit to form a "crown," the whole being borne on a short stalk-cell. The chimney-like passage between the cells of the crown becomes filled with mucilage, and the male gametes entering this work their way through to the egg-cell, and fertilisation is effected. The egg-cell is fertilised and undergoes further development inside its envelope, and is not liberated therefrom. Hence it will be seen that, reproductively, Chara is about on a level with Oedogonium, but there is a considerably higher degree of specialisation.

We may now pass on to consider a few types from the other sub-classes of Algae, taking first two examples from the Phaeophyceae, or Brown Algae. Brown Algae are familiar to everybody, forming as they do the bulk of the seaweeds on every rocky coast. With unimportant exceptions they are entirely marine. The brown colour is due to a pigment known as phycophaein, which disguises the green colour of the chlorophyll which is also present. It may be noted that some authorities place the Diatomaceae in this sub-class, while others place them among the green Algae, near the desmids, taking the view that the obvious affinities are more important than considerations based on colour.

The first of these types that we shall consider is Ectocarpus, several species of which are common, epiphytic on larger Algae, or attached to submerged woodwork, etc. The plant body is filamentous, and consists of a creeping portion and a tuft of branched threads—each a cell-row—which may be several inches long. These threads are somewhat peculiar in that the growing point is not terminal, but intercalary, usually near the base of the filament.

Ectocarpus has two kinds of reproductive organs which arise as lateral branches on the filaments, usually on different individuals. These organs are distinguished as unilocular (one-celled) and plurilocular (many-celled) sporangia. The unilocular sporangia are globular bodies, of which the protoplasm becomes divided up into a large number of ciliated swarm-spores, which are liberated by the rupture of the sporangium at its apex, and swim about in the water. These swarm-spores differ from those that we have previously met in that their cilia are attached laterally, and during the period of activity one points forward and the other backwards. This is characteristic of the Phaeophyceae.

After a short period of activity the swarm-spores settle down and give rise to new plants. This method of reproduction is therefore asexual, and corresponds to a method we have seen in Ulothrix among the green Algae.

In the plurilocular sporangia there is development from a side branch, during which the cells divide repeatedly so as to form a structure composed of a very large number of small cubical cells, from each of which one, two, or three swarm-spores are produced. After liberation these swarm-spores may fuse in pairs; showing that they are sexual cells, and from the zygospore thus formed a new plant arises. Some observers claim to have seen "swarming," a process in which one swarm-spore, which we must regard as female, becomes relatively stationary, while others, to be regarded as male, cluster around it, and ultimately fusion takes place between the female cell and one of the male cells. It is, however, to be noted that, if fusion for any reason does not occur, these swarm-spores, like those from the unilocular sporangia, are capable of settling down and forming new plants. Hence in this respect also we may regard Ectocarpus as being reproductively on a level with Ulothrix—in both cases the sexual character is not very firmly established, and the sexual cells are still capable of asexual development.

For our next type we may take a species of Fucus—THE seaweed in most people's minds. Various species are abundant, and they form the bulk of the vegetation between tide-marks. What follows applies chiefly to F. vesiculosus. This plant is too well known to need much description. It consists of a strap-shaped, much-branched thallus, the branching being dichotomous. There is a distinct mid-rib, and here and there we find air-vesicles which help in the flotation of the plant. At the base we find a disc-like expansion by which the plant is attached to a rock or other substratum. The ends of some of the branches are swollen into rounded or oval masses of highly mucilaginous tissue, on the surface of which numerous dots may be seen. If a section of one of these masses be taken, it will be found that each dot marks the position of a flash-shaped conceptacle, opening at the surface by a minute pore—the ostiole. The walls of the conceptacle are covered with multi-cellular hairs, some of which project through the ostiole. Among these hairs the reproductive organs are found. These are of two kinds, but in F. vesiculosus only one kind will be found on any given plant. The male organs are one-celled, and are borne on branched hairs mingling with the simple hairs previously mentioned. The protoplasm of the cell divides up into numerous sperm-cells (antherozoids) which escape by the rupture of the parent cell, and ultimately find their way into the surrounding water. (If a plant at the right stage of development is kept in air for some hours, the mass of sperm-cells may be seen at each ostiole with the naked eye.) These male elements are naked specks of protoplasm, of an elongated pear shape, with the two lateral cilia usually found in the brown seaweeds. They swim about actively for a short time.

The female organs are developed in conceptacles just as the male organs are, but are relatively large, and each grows on its own individual stalk-cell. The contained protoplasm divides into eight egg-cells. At maturity the entire female organ is detached and escapes into the water, when it ruptures and liberates the egg-cells. Both egg-cells and sperm-cells are liberated as the tide rises over the plants; the sperm-cells swarm round the egg-cells, and by their motion cause the latter to rotate; finally one sperm-cell unites with the egg-cell and fertilisation is effected. From the fertilised egg-cell a new plant is developed. No asexual method of reproduction is found in Fucus.

From the above it will be seen that, sexually, Fucus is at about the same level as Volvox. Vegetatively, it is, of course, at a much higher level. It is also to be noted that in F. vesiculosus we have a comparatively high degree of sexuality—we find not only male and female gametes, but distinct male and female organs and male and female plants. In other species of Fucus, however, the sexual character is not so fully developed, male and female conceptacles may occur on the same plant, or even male and female organs in the same conceptacle.

We shall now pass on to the consideration of a few types drawn from the highest class of Algae—the Rhodophyceae, or Red Algae. With a few exceptions, of which perhaps the best known is Batrachospermum—recently found by members of this Society at Logiealmond, Methven Loch, and in Gleneagles—the Red Algae are marine. They abound in rock-pools from high-water mark downwards, but are most plentiful in deeper water, and the best place to find them is on rocky shores about low-water mark of spring tides. Their red colour is due to a pigment, phycoerythrin, which masks the green colour of the chlorophyll, and is closely associated with the nature of the habitat. To quote Kerner: "The conditions of illumination for plants growing in the depths of the ocean are quite unfavourable. It is not only that a portion of the light falling on the surface of the water is reflected, and the other portion weakened by its passage through the water, but besides, those rays which are necessary to the formation of organic matter by the chlorophyll granules in the plant cells are abstracted from the white light which passes through, for the chlorophyll granules need just the red, yellow, and orange rays if they are to perform their functions; only under the influence of these rays can the decomposition of carbonic acid, the separation of oxygen, and the formation of carbohydrates take place. The blue rays do not assist at all in this respect; they are even hurtful to these processes, since they assist the oxidation, that is, the decomposition of organic substance.

"Consequently phycoerythrin, the red pigment of the Florideae (Red Algae), now appears, and indeed so abundantly that the chlorophyll granules in the interior are quite hidden by it. This colouring matter displays a marked fluorescence, that is to say, it absorbs a large portion of the light rays falling on it, and gives out other rays of a greater wave length. The blue rays are to some extent changed by it to yellow, orange, and red, and thus the chlorophyll granules finally receive those rays which act as the propelling force in the decomposition of carbonic acid.

"But this also affords an explanation of the remarkable phenomenon that sea-plants are only coloured green close to the shore, and only in the most superficial layers of water, while lower down they appear red. Only quite on the surface the emerald-like Ulvaceae and Enteromorphas sway hither and thither, forming thus a light green belt; these Algae are to be sought in vain in the depths beneath; of the plants which flourish below this region it can no longer be said that they grow green; this mark of vegetation has entirely vanished. Green has given place to red. All the innumerable Florideae are reddened—sometimes a most delicate carmine, sometimes a deep purple; then again a light brownish red and a dull dark crimson, and as we admire in the bush the innumerable gradations of green colour, so is the eye delighted in the manifold shades of red, in which the different variegated species of Florideae, intermixing with one another, display themselves."

The Red Algae take various forms. They may be filamentous and delicate, or leaf-like. They are epiphytic on larger Algae, or grow attached to rocks.

We select for our first type the genus Nemalion, as the reproductive organs, at all events in their earlier stages, are comparatively simple. Nemalion is a soft, cord-like branching plant; each branch consisting of a central axis surrounded by short filaments pointing outwards, the whole being held together by a gelatinous substance. The male organs are very simple; each consisting of a single cell developed as one of a terminal cluster. Each of these male organs gives rise to a single spherical sperm-cell, which is non-mobile, as it possesses no cilia—the first of the kind we have met. The female organ consists of the terminal cell of a short branch, and is peculiar in bearing a relatively long hair-like extension. This extension is known as a trichogyne, and the whole bears a superficial resemblance to the ovary, style, and stigma of a flowering plant. The latter is, however, apart from its size, a complicated multicellular structure, while the female organ of Nemalion is a single cell.

The germ-cells are formed singly in the female organs. The sperm-cells are carried passively by the water and adhere to the trichogyne; the dividing walls are probably absorbed at the point of contact, and the nucleus passes down the trichogyne and fuses with the nucleus of the female cell at its base. Thus fertilisation is effected; but the subsequent development is different from anything we have yet seen. The fertilised female cell does not give rise directly to a new plant. Instead it proceeds to branch out into new filaments, which form a dense globular cluster, topped by the withered remnant of the trichogyne. The terminal cells of the filaments become asexual spores, from which the new Nemalion plants arise.

It is evident that we have here something quite different from what we have met with in previous types, so much so that a new nomenclature is called for. The passive male gamete is termed a spermatium; the unfertilised female cell is a carpogonium; the resulting fruitification a cystocarp; and the asexual spores are carpospores. The essential point to be noted is that we have an asexual stage inserted between two generations of gamete-bearing plants. The significance of this will be referred to later.

For our final type let us select the genus Polysiphonia. There are about a dozen British species of this genus, P. fastigiata being one of the commonest. This plant appears as reddish brown tufts, often on the well-known Anophyllum nodosum, of filaments about two inches long. The vegetative part of the plant consists of elongated cells, termed " siphons " —an axial row being surrounded by others—and forms a very beautiful object with a low power of the microscope. When we come to investigate the reproductive processes we find that there are three types of plant. In some we find near the ends of branches certain rounded swellings, and each swelling is found to contain four reproductive cells arranged tetrahedrally, and hence termed tetraspores. These tetraspores are capable of giving rise to a new plant, and hence illustrate asexual reproduction. The tetrasporic plant is in itself asexual, as it never bears sexual organs.

The other two forms of the plant are the sexual forms. The male plant bears male organs in the form of modified branches, of which the external cells, when mature, become spermatia exactly like those of Nemalion. The female plants bear carpogonia, each with its trichogyne, and accompanied by a number of vegetative cells which after fertilisation help in the formation of the cystocarp. The whole structure is essentially the same as in Nemalion, but is much more complicated. Fertilisation is effected as in Nemalion, the spermatia being carried passively to the trichogyne by the water. After fertilisation a remarkable series of changes take place; a large fusion-cell is formed by the union of the carpogonium with some of the surrounding vegetative cells, and this gives rise in the ordinary way to carpospores; meanwhile the other vegetative cells connected with the carpogonium grow and divide in such a way as to produce an urn-shaped envelope, which surrounds the cystocarp proper. The carpospores ultimately are set free and give rise to new plants; and it has been shown that carpospores give rise to tetrasporic plants, and tetraspores to sexual plants.

We may conveniently bring this paper to a close by a few considerations of a general nature. In our simplest type we found that reproduction was purely vegetative—there being no sign of any sexual process.. Thus, successive generations of Oscillatoria might be represented graphically thus:—

P — P — P — P etc.
(P = plant.)

At a somewhat higher stage, exemplified by Sphaerella lacustris, we find an intermediate stage, actively mobile swarm-spores, inserted between two generations of the plant in its typical form. These swarm-spores are asexual, and our diagram would become:—

P — A.S. — P — A.S. — P — A.S. etc.
(A.S. = Asexual spore.)

In other types we meet with a distinct sexual process—*i.e.*, reproduction is dependent upon the union of two distinct cells, one of which we must regard as male and the other as female, even though they may be externally identical. In many cases, however, the female cell may be identified by its larger size and comparative or absolute passivity. These sexual cells we term gametes, and the form of any particular plant which bears them is the gametophyte. The result of the process of fertilisation is a sexually produced spore, which is known by various names depending upon the type of fertilisation—in cases of isogamy it is known as a zygospore, and in anisogamy as an oöspore. The essential point is that in all cases it is a sexually-produced spore, giving rise directly or indirectly to plants like the original gametophyte. To meet these cases, illustrated by Spirogyra and the majority of our types, our diagram would become:—

$$\text{G.}\left\{\begin{array}{c}\text{—g.—}\\ \\ \text{—g.—}\end{array}\right\}\text{S.S.—G.}\left\{\begin{array}{c}\text{—g.—}\\ \\ \text{—g.—}\end{array}\right\}\text{S.S.—G. etc.}$$

(G = gametophyte; g = gametes; S.S. = sexually produced spore)

When we come to the Red Algae, however, we find that the matter is further complicated. The result of fertilisation here is not a spore which gives rise at once to a new generation like the parent plant. An asexual phase is interpolated, represented by the cystocarp (and the tetrasporic plant when present), in which asexual spores are produced, and these in turn give rise to the sexual plant. This stage is known as the sporophyte. Our diagram therefore requires further extension, thus:—

$$\text{G.}\left\{\begin{matrix}\text{—g.—}\\ \\ \text{—g.—}\end{matrix}\right\}\text{S.—A.S.—G.}\left\{\begin{matrix}\text{—g.—}\\ \\ \text{—g.—}\end{matrix}\right\}\text{S.—A.S.—G. etc.}$$

(S = sporophyte, in this case the cystocarp and tetrasporic plant; A.S. = asexually-produced spores, *i.e.*, carpospores and tetraspores.)

This alternation of a gamete-bearing stage and a non-sexual spore-bearing stage in the life-history of a plant is known as alternation of generations, and is one of the most important and widely-spread phenomena in the whole of the vegetable kingdom. Foreshadowed, so to speak, in the Red Algae, and in certain Fungi, it attains its most prominent development in the Bryophyta (Mosses and their allies) and in the Pteridophyta (Ferns and related plants). In the Gymnosperms and Angiosperms it tends to be obscured by reduction of the gametophyte stage, but traces of it can be seen throughout. So widespread a phenomenon must have some deep significance, and it would appear to be this—that it affords a means for the development of numerous progeny from one act of fertilisation. Compare Fucus with Polysiphonia. In the former each fertilised egg-cell gives rise to one new plant. In the latter each fertilised carpogonium gives rise to numerous carpospores, each of which may give rise to a new plant. Thus in Polysiphonia the disadvantage of having passive gametes—rendering fertilisation comparatively fortuitous—is counterbalanced by the advantage due to alternation of generations.

The absence of alternation of generations from our earlier types is possibly correlated with the remarkable degree of asexual reproductivity which they exhibit. In Ulothrix, for example, the sexual character has not been very firmly established, and the bi-ciliate gametes may develop into new plants just as the tetra-ciliate swarm-spores. In general, it would appear that as the sexual character became more and more highly specialised the need for some such principle as alternation of generations would become more apparent, and it may have arisen from some such procedure as we find in Ulothrix, where the zygospore does not at once grow into a plant like the parent, but produces swarm-spores as an intermediate stage.

IX.—*The Hill Trenches of Perthshire.*

By WILLIAM THOMSON, F.S.A.SCOT.

(Read 13th November, 1925.)

Within a radius of fourteen miles, in the centre of the Perthshire highlands, are several series of mounds, ridges or terraces, which have given rise to much speculation as to their origin and purpose.

In every instance these are known locally as "The Trenches," are associated traditionally with purposes of defence or defiance, and are vaguely asserted to have been built by the Romans or the Picts.

Of the four groups or series of terraces included in the ambit of these notes, the most accessible is that of Ardchullarie, at the southern end of Glen Ample, on the east side of Loch Lubnaig, at the point where the knee-like bend gives that beautiful sheet of water its name. This is also the spot where Scott places the meeting between bold Dugald Dalgety and the Earl of Menteith in his Legend of Montrose. A less known but authentic incident connects Rob Roy with the place, for here, in 1717-18, he escaped from the soldiers who had captured him at Monachyle Tuarach beyond Loch Voil and were hastening south with their notable captive. Rob bolted up Glen Ample where the "trenches" are.

The group in Kirkton Glen, Balquhidder, is reached from the Kirkton of Balquhidder by the path leading by the side of the old church where Rob lies buried. They are situated about a mile up the glen.

Those in Gleann Meann are more remote, and can only be reached from Glen Buckie on the north or Achnahard farm on the south. This farm is at the junction of Gleann Meann and Glen Finglas. The "trenches" are two miles up the glen from here.

The fourth group is about four and a half miles from Crianlarich, on a hill called "An Caisteal," one of a remarkably steep and rugged combination of summits. The trenches are nearly three thousand feet up and close to the top of this hill.

All four groups are on hillslopes facing westward; they extend almost due north and south, and therefore face the west, at altitudes ranging from 800 to 3,000 feet.

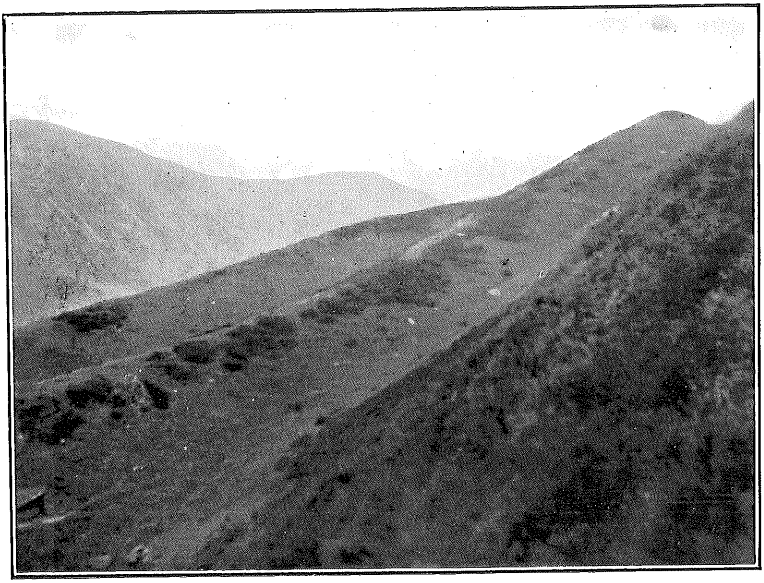


Plate 18. The Hill "Trenches" at Ardchullarie, looking north up Glen Ample.
[*Photo by Wm. Thomson, F.S.A. Scot.*

Their general features are very similar—mounds or ridges or terraces with sharp hollows behind. The dip towards the hill varies from two feet in the most obliterated to twelve and fifteen feet in the most strongly marked. Tops of mounds and hollows behind are covered with grass, in one instance—Gleann Meann—with bracken, on the lower ones only. Even on An Caisteal, where the trenches are near the 3,000 feet contour level, ridges and hollows are grass grown even though the hillsides, above and below, are entirely bare of verdure.

So far as I have been able to ascertain, three gentlemen have left written records of visits to these "Trenches." First, Major Mackintosh Gow, in Vol. XXI. of the Proceedings of the Society of Antiquaries of Scotland, describes those in Kirkton Glen as "fortifications, with accommodation behind, where many hundreds of men might be sheltered from the view of any one coming up the hill," and refers to "foundations of several dwellings" within the bounds of one of the higher terraces.

Second, the Rev. G. A. F. Knight, in Vol. V. of the P.S.N.S., January, 1913, gives a very fair and accurate account of these same trenches, which he had examined and measured with care. He counted from the lowest to the highest eight lines of "fortifications." Thus Mr. Knight—"Such are these remarkable fortifications on this lonely hill-side. They certainly reveal enormous labour and no small skill in their construction. Who their builders were we have no clue, though the Picts are credited with the work of their erection." He concludes by hoping that some skilled archæologist, who is also a military strategist, should make a thorough study of remains so extensive and extraordinary.

Third and last, the Rev. George Walker, B.D., in his pamphlet on "The Ancient Camps near Callander," gives a graphic description of the trenches at Ardchullarie. He writes that "Careful inspection leads to the conviction that they are the remains of defensive structures. They must have served as a bulwark against the approach of invaders from the south." Again, on p. 15, he speaks of them as "Monumental proofs of the determination with which the people of the hills guarded the openings into their territory against the approach of these strangers." In the preface to a second edition Mr. Walker states "He does not see any reasons to depart from the conclusions he had formed."

It should be noted that each of these three writers visited only one series of "Trenches," and might not be aware of the existence, in the vicinity, of others.

I have since ascertained that Major Mackintosh Gow wrote the O.S. Dept. regarding the Kirkton Glen trenches, and they sent a surveyor specially to investigate these features. Following his report, it was decided to show them as "embankments," not "antiquities," and thus they appear on the 6″ O.S. map to-day. The O.S. Dept. were kind enough to send me a copy of the surveyor's report, in which he admits that—" Looked at casually they have all the appearance of ancient fortifications in an excellent state of preservation, but closer inspection shows:—

1—That the embankments are not composed of stone and earth, but are formed of rocks, or ledges of rocks, which crop out distinctly here and there along the tops of all three embankments.

2—That the embankments are situated on extensive landslips, embracing great masses of rock all riven and fissured by the subsidence, the lines of fracture running generally parallel with these embankments.

3—That on the flattish ground these rents and fissures are still gaping open, but on the steep ground have been filled up, wholly in some cases, partially in others, by debris falling from above, and that, where the crevice has only been partially filled up, the lower lip of the fissure has all the appearance of an artificial bank with an entrenchment behind."

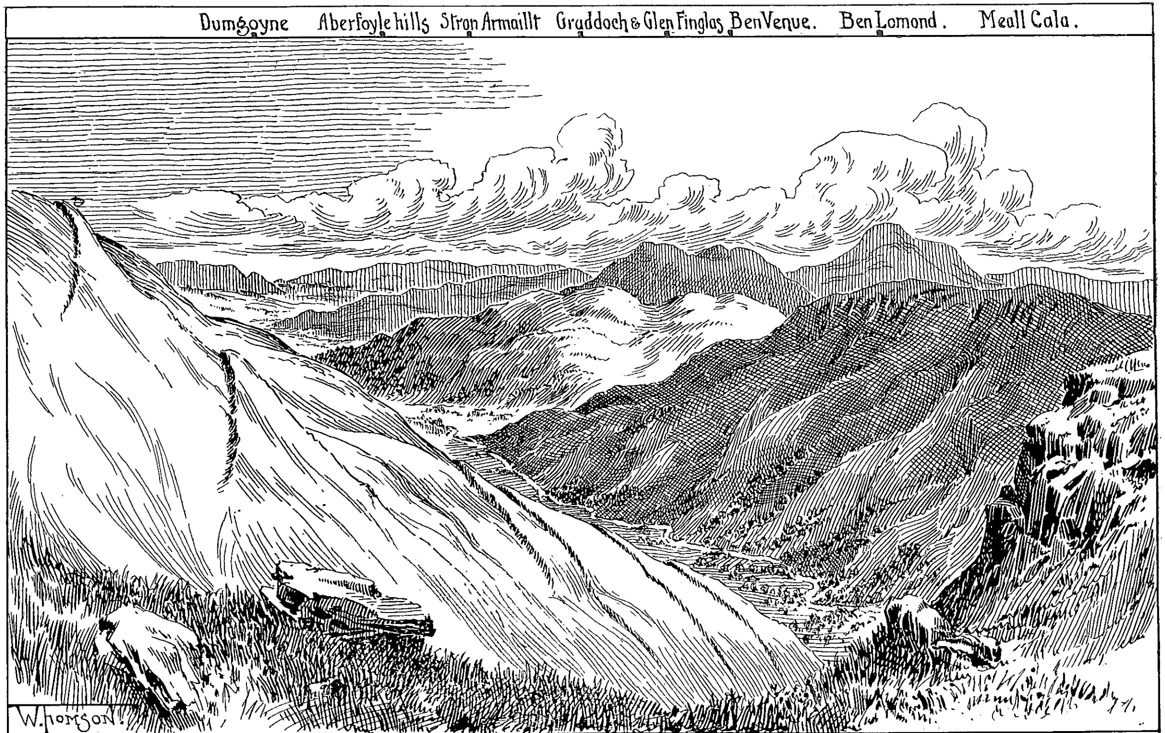
As one who has visited, examined and measured very carefully the four series of trenches referred to, I am of opinion that the O.S. Dept. give the true explanation of the presence of these curious natural features.

An examination of the geological map of Perthshire reveals the presence of a great fault running almost due north, deciding, at one point we are dealing with, the line of Glen Ample, at the south end of which the Ardchullarie trenches lie.

In correspondence with Brigadier-General Stirling, he states—" The mounds above Ardchullarie burn are of a kind not uncommon at the mouths of steep glens, but perhaps they are particularly well marked at this point, and it is difficult to account for them." And again—" The Ardchullarie trenches are just opposite the line of the large fault which runs from Loch Tay to Ben Ledi, through Glen Beith and Glen Ample. Such line of fault is supposed to be particularly liable to earthquakes, and this gives support to the suggestion that seismic disturbance may have been the original cause of their formation." Accepting such an explanation of their origin, they must then have been pre-glacial.

Referring now to the Glacial Drift map of Perthshire, we find all four glens we are dealing with filled with glacial deposits, and the deposition of this detritus would go far to fill up the deep rifts caused by the rock subsidence, and would also give direction to streamlets flowing under and from the melting ice. The direction of the iceflow was from N.W. to S.E. throughout the district under review, or almost at right angles to all the trenches.

On An Caisteal the trenches are at an altitude of nearly 3,000 feet, and are shown as " rock surface " on the Glacial



View from Ben Bhan showing series of Terraces on slope down to Gleann nam Meann, Meall Cala beyond, Creag na h' Easaig to right.

Plate 21. The Hill " Trenches," Gleann Meann, from summit of Ben Bhan, looking south.

map. They would therefore be clear of the heavy deposit, which lower " trenches " would bear, and might accordingly be expected to show sharp, jagged edges of fractured rock. And this is exactly what we find. This supports the theory of landslips, the cause of which might be seismic disturbance.

We have on the Kilpatrick hills, near Glasgow, a well-known rock fissure, popularly known as the " Whangie." In this case the rift is still open, and one can walk through it from end to end. The rock walls are some 60 feet high, and the chasm is but three feet wide at bottom. There are other similar but smaller fissures in the line of these hills, and, if we try to imagine them nearly filled with broken rock and earth, we get an approach to our Perthshire " trenches."

Dealing now with the Balquhidder groups seriatim, the following facts are established.

1—The uppermost Ardchullarie trenches are the largest, decreasing in size—though this is not regular—as lower levels are reached. The highest are at, or near, the 1,750 feet level.

2—The smallest and least notable of the Gleann Meann trenches are uppermost, and they increase in size as we descend. The highest are at, or near, the 2,400 feet level.

3—The Kirkton Glen series begin at the same height as those in Gleann Meann. At the top are open, ragged rock fissures, choked with broken masses. The trenches become larger and more like vast embankments towards the middle level, and thereafter decrease to insignificance. In other words, they are almost wholly filled up as the bottom of the glen is neared.

4—The An Caisteal series occur at an elevation of almost 3,000 feet, and show quite definitely and unmistakably sharp edges of shattered rock—the outer lips of the original fissures. These trenches are much smaller than the others, but are worth special notice as giving clear evidence as to origin.

All of the four series occur on schistose rocks. The ridges are separated by irregular intervals. Some are straight, others are curved or crooked. They are spread over the hill surface in irregular manner, sometimes with an upward inclination northward and again in the contrary direction. These irregularities could not be satisfactorily explained if an artificial origin were postulated.

ARDCHULLARIE GROUP.

In this group I counted and measured 11 very conspicuous ridges in length from 50 to 700 feet, height varying from 5 to 20 feet, at altitudes from 1,750 to about 900 feet. They were from 3 to 10 feet broad on top, and the distance between the various units was from 50 to 300 feet. Tops and inner sides almost always covered with grass, outer slopes with heather. Springs rise between the two uppermost and those shown in Plate 19. Speaking generally, the ends simply merge into the adjacent hillside. In two hollows about the 1,000 feet level remains of foundations were noted. Tests on ridges showed the top covering to be soil and small stones to a depth of from 9 to 12 inches. At various points there are outcrops of rock, probably the edge of the primal fissures. The mounds continue right down to the ravine in which the Ardchullarie burn flows, shown at right side of Plate 19.

IRON SLAGS.

The presence of two heaps of iron slags should be noted. One close to the path on the north side of Ardchullarie burn, at or near the 1,100 feet level, the other on the opposite side of the stream on top of one of the minor mounds. The Gaelic name for the wooded part of the ravine above which these heaps occur is Cuil Bheithe, or the Corner of the Birches, a name given, in all likelihood, many centuries ago, and this would be the source from which the Celtic metallurgists secured supplies of wood to be transformed into charcoal for their primitive furnaces.

Perthshire offers a fertile field for the elucidation of the story of the Iron Slag Heaps, of which so little is known. They have been found in a cave in East Fife in such close association with fragments of Roman pottery as to compel the conclusion that they were contemporary with the Roman occupation, and a furnace and slags have been found in Caithness-shire dating from the very early centuries of our era. They may easily date from a much earlier period.

GLEANN MEANN TRENCHES.

Measuring on the one-inch O.S. map across L. Lubnaig to the summit of Ben Vane—3½ miles almost due west—and assuming we have crossed the hills to that elevated point—2,685 feet—we look down into Gleann Meann and across intervening hilltops to a wide and magnificent prospect. Ben Lomond forms the skyline to the west, with Ben Venue further south and on to far-away Dumgoyne at the end of the Strathblane hills. Meall Cala defines the further side of the glen—the sanctuary for the deer when royalty in the long ago hunted in Glen Finglas forest. The glen itself forms a natural access to the north, and has been used as such from remotest times.

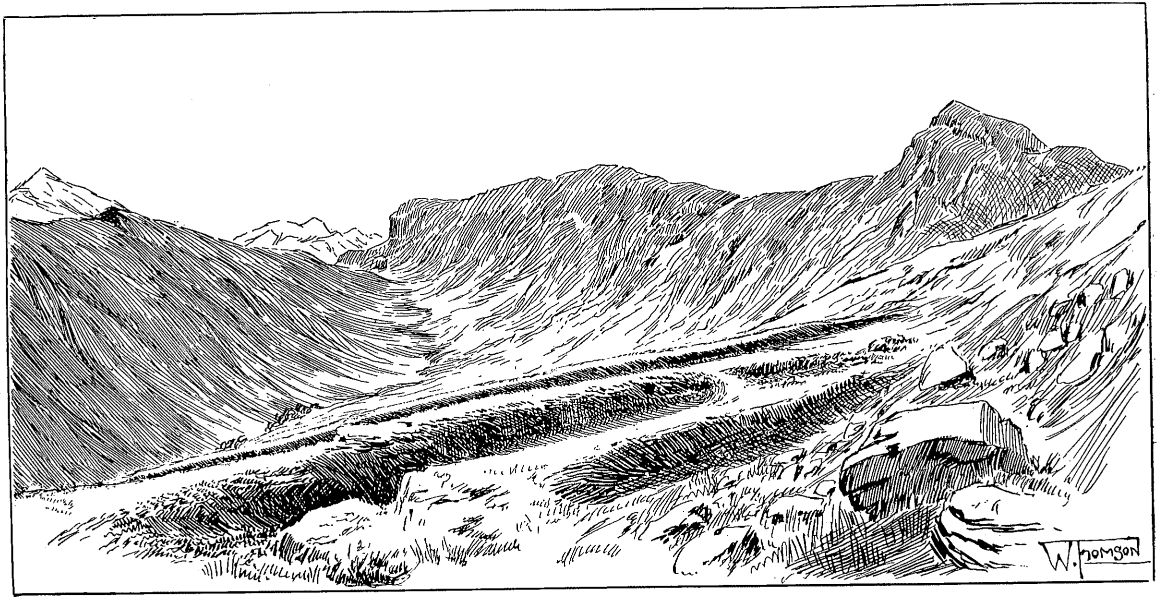


Plate 20. The Hill "Trenches" in Kirkton Glen, Balquhidder. Looking north-west. Ben More (left) and Ben Doran (centre) in distance.

But what interests us most are the roughly parallel lines traversing the hillslope below. These are the "Trenches" of Gleann Meann, like others facing due west and running north and south. Close by rises the rocky bluff of Creag Naissaig, with the Allt Ghamhain tumbling in glittering cascades to the main stream, whose course can be followed for miles southward.

Beyond the burn, on the grassy hillside, at an elevation of 2,400 feet, the line of the first of the ridges is clearly seen. It is the smallest of all, being only three or four feet deep and 100 feet long, running out to bare rock at the southern end. From this marking, in a descent of about 1,300 feet, nine trenches or ridges were examined and measured.

Intervening distances ranged from 60 to 800 feet, the maximum occurring near the middle of the slope at an elevation of about 1,700 feet. Height varied from 3 to 10 feet in the eighth and largest, which ends abruptly at a small hill stream. This one is 780 feet long, with breaks at two places, through which water was flowing. Bare rock protruding in large blocks happens frequently. The ridges curve in towards, and approach nearer, the Allt Ghamhian as we descend, and they show a prevailing declination towards the north.

KIRKTON GLEN TRENCHES.

Continuing our journey up Gleann Meann, we pass the watershed and into Glen Buckie, in which are iron slag heaps, and the curious, if not unique, circle and cup-marked stone called Leac nan Saighead, or the Stone of the Arrow. This glen is 700 feet above sea level, and is packed with glacial detritus through which the Calair burn cuts its course. From thence we reach Loch Voil and Balquhidder, and about a mile north of the old church come in sight of the next series of trenches. They are again on the east side, run north and south, and begin at the 2,400 feet level. They are marked on the six-inch O.S. map, an honour due to circumstances already referred to, and not shared by any of the others. Their site is easily detected by the crags at their southern end, seen from the path. Climbing above these cliffs, we see the highest evidences of disturbance. Signs of a tremendous landslip are obvious and convincing.

Open fissures are numerous, with, between them, grass-covered mounds, bending and twisting but invariably trending north and south. Lower down they become smoother, more regular, straighter, and carrying, despite oneself, a feeling of artificiality. I investigated, on different occasions, every part of the fractured hillside, and measured accurately a series of four directly above the crags, and another of eight ridges a little to the north, the series visited by the Rev. G. A. F. Knight.

Above the crags shattered and riven rocks prove the correctness of the landslip theory. Evidences of extensive fracture are everywhere apparent. Here the ridges rise and fall with the sinuosities of the present ground levels, and are piled right above the precipice, the whole mass of which even now suggests a tendency to fall forward. A lofty pinnacle, torn from the main mass of rock, shows very strikingly how the ridges were formed. None of this upper series is notable for size.

In the main series the embankments are separated by distances of from 24 to 150 feet, their length ranging from 50 to 780 feet. Near the middle, at number 4, which is 470 feet long, the trench becomes a narrow cleft between two walls of solid rock, connecting with a rearward trench by an aperture underneath. This is the cave alluded to by the Rev. G. A. F. Knight in his notes. Three terraces are shown on Plate 20. Depth at the rocky—south—end about 15 feet, after which the hollow shallows rapidly and disappears. The hollow between, as the drawing shows, is blocked traversely, so that it is possible to walk along the parapet and across from one to the other. Below the last of this series, towards the bottom of the glen, traces of well-nigh obliterated trenches may be seen.

AN CAISTEAL TRENCHES.

These are the most westerly, the highest, and without doubt the result of landslip and fracture. They occur near the fort-like summit of An Caisteal, a mountain 3,265 feet high on the eastern side of Glen Falloch at the top of the Coire Andoran.

There are three trenches only, the first and highest beginning about 100 feet north of the actual summit, near the 3,000 feet level. It varies from 2 to 5 feet in depth, the rock forming the lip of the fissure projects, stark and rugged here and there. It is 450 feet long.

110 feet below, measured down the excessively steep slope, is the second trench, 260 feet long with a hole ten feet deep at its southern end. Another 100 feet lower lies the third and last of this group. 216 feet long and about 5 feet deep, it forms a striking line on the hillside when viewed from above. All three bend and twist considerably out and in and up and down, though always their direction is nearly north and south with a definite upward inclination to the north.

The work of investigating these natural features was heavy, but it has left me with a firm conviction that all of them are due to disturbances of the basic rock of which the hills are formed. Originally this would probably be seismic.

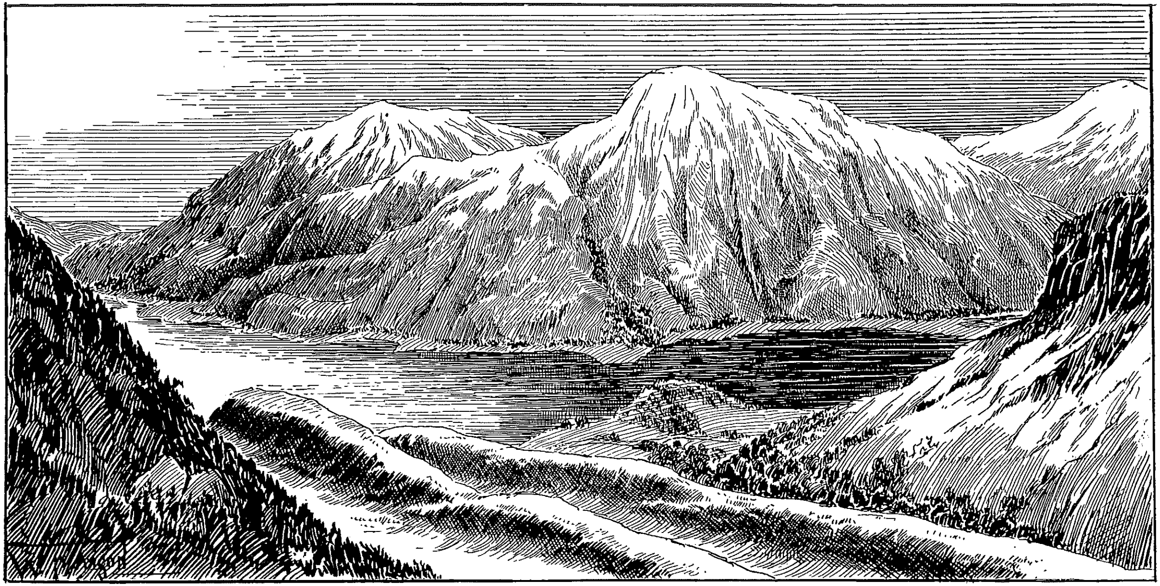


Plate 19. The Hill "Trenches" at Ardchullarie, looking south across Loch Lubnaig. Ben Bhan in distance to right, on whose further slopes are the Gleann Meann "Trenches."

Deposition of glacial deposits, coming later, filled, levelled, and rounded off the inequalities of the primal fractures, leaving the Trenches as we see them to-day, surprising the casual visitor and giving rise, as we have seen, to ideas and conclusions which do not stand the test to which, for the first time, they have been subjected.

X.—*Four Days on Ben Lawers.*

(*August 9th to 13th, 1924.*)

By John Gladstone.

(Read 12th February, 1926.)

Note.—This is merely a short account of four days spent botanising on Ben Lawers. There has been no effort to group systematically the flowers found there, but it is only meant to serve as a short botanical diary of days happily spent in one of the most beautiful districts of the Highlands.

> " My savage journey, curious, I pursue,
> Till fam'd Breadalbane opens to my view,
> The meeting cliffs each deep sunk glen divides,
> The woods, wide scattered, clothe their ample sides,
> Th' outstretching lake, inbosomed 'mong the hills,
> The eye with wonder and amazement fills."
> —Burns.[1]

" Of all the British mountains, Ben Lawers is the richest in rare and interesting Alpine species."—Hugh Macmillan.[2]

Saturday, August 9th, 1924.—Reading these words in the winter, we determined to visit the Breadalbane mountains in the summer. After arriving at Killin, and failing to find lodgings there, we took the steamer to Lawers, and found rooms at the little farmhouse of Croftintygan, by the side of the lake. It was a sunny day, and the farmers were busy at their hay. We started out in the afternoon, and went through a few fields before we reached the lower slopes of the hill.

[1]Robert Burns: From verses written with a pencil over the chimney piece in the parlour of the inn at Kenmore, Taymouth. *The Poetry of Robert Burns*: Centenary Edition: London, 1896: p. 301.
[2]Rev. Hugh Macmillan: *Holidays in High Lands*: London, 1869: p. 48.

Our first find was Sagifraga azoides, L., growing in yellow clusters on the banks of the stream. Going further up, we found Polygonum viviparum, L. Unused to finding even two new flowers in a day, we thought we had found enough, and hastened back to identify them. Among other plants seen this day and on subsequent days on Lower Ben Lawers below 1,500 feet were:—Drosera rotundifolia, L.; Gentiana campestris, L.; Parnassia palustris, L.; Habernaria viridis, Br.; Pinguicula vulgaris, L.; Carduus heterophyllus, L.; Linum catharticum, L.; Narthecium ossifragum, Huds.; Briza media, L.; Habenaria conopsea, L.; Antennaria dioica, Sow.

SUNDAY, AUGUST 10TH.—Next morning we started soon after breakfast, and, passing through the same part of the hill as we had gone the day before, we soon found higher up:—Saxifraga stellaris, L., and Lycopodium alpinum, L.; besides seeing Lycopodium clavatum, L.; Lycopodium Selago, L.; and Alchemilla alpina, L., which is abundant on the mid slopes of the hill. Soon after, by the side of the stream 2,000 feet up, we saw more of the Saxifraga stellaris and also Salix Myrsititis, L., and Salix arbuscula, L. Nothing more was found till we reached the highest ridge, where we saw Silene acaulis, L., and Arenaria Cherleri, Benth. Coming down, we found Tofieldia palustris, Huds. Among other flowers (not new to us) also seen were Sedum villosum, L.; Lysimachia nummularia, L.; Rubus Chamaemorus, L.; and Empetrum nigrum, L., besides a flock of about 50 ptarmigan.

MONDAY, AUGUST 11TH.—It was raining when we woke up, so we stayed in all the morning and identified our finds. In the afternoon we went down to Lawers Pier intending to take the steamer to Kenmore. However, the steamer did not call, and we went back to the house. In the evening it cleared up and we went for a little walk in the same kind of country as we were in on Saturday. Here, besides the flowers seen on Saturday, we found Menyanthes trifoliata, L.; Botrychium Lunaria, Sow.; and Ononis arvensis, L.

TUESDAY, AUGUST 12TH.—It was a fine day, although there was mist round the top of Ben Lawers. Our only find on the way up was Epilobium alpinum, L. After going further than the point reached on Sunday we found on the very top Draba incana, L., and Cerastium alpinum, L. After this we were thinking of going down the usual way, but, remembering Macmillan's description[3] of the corrie where many rare Alpine plants grow, and seeing Lochan-a-chait glittering through the mist, we went down to this marvellously sheltered corrie, over 3,500 feet up, with high overhanging rocks and moist soil. Here we found Myosotis alpestris, Schmidt; Gnaphalium norvegicum, Gunner; Veronica alpina, L.; Oxyria reniformis, Campd.; Sedum Rhodolia, D.C.; Aspidium Lonchitis, Sow.;

[3]Rev. Hugh Macmillan: *Holidays in High Lands*: p. 53.

besides seeing Saxifraga hypnoides, L., and Festuca vivipara, Sm. We went down to the Lochan, and made our way home through quite different country without, however, finding anything else in the peaty soil. Next day we went home, having found eighteen flowers new to us.

Among the flowers mentioned by Macmillan[4] as growing on Ben Lawers that we failed to find are:—Gentiana nivalis, L.; Alsine rubella, Hook.; Sibbaldia procumbens, L.; Draba rupestris, Br.; of which G. C. Druce[5] in 1900 says:—"This plant appears to have lately become less frequent on Ben Lawers, and now to have disappeared altogether." There is also the rare Saxifraga cernua, L., which Druce[5] in 1900 mentions, together with Gentiana nivalis, saying that they are not less plentiful than they were twenty years ago. However, Bentham,[6] in 1912, says:—"It very seldom flowers and is now almost extinct."

Saxifraga rivularis, L., is also mentioned by Bentham[7] as growing on Ben Lawers, but not by Macmillan. Druce[8] in 1900 said that it was so scarce that a single collector might easily eradicate it. It is quite likely that during the twenty-four years which have elapsed since these words were written these three rare plants have completely disappeared. Now (1924), there is quite a worn path at the top of Ben Lawers, and people are always climbing the hill.

XI.—*Field Notes on Some Birds of Perthshire and the Faunal Area of "Tay."*

Together with occurrences of Rare Birds recently recorded.

By Lord Scone, B.A., F.Z.S., M.B.O.U.

(Read 12th February, 1926.)

These observations were made mostly during the period 1922-26, and are not claimed to be in any way exhaustive. Other records are taken from "British Birds" and "The Scottish Naturalist."

Starling (Sturnus v. vulgaris. L.) Among many thousands of Starlings which roosted for some years in Quarrymill

[4]Rev. Hugh Macmillan: *Holidays in High Lands*: pp. 52/54.
[5]G. C. Druce: *Notes on the Flora of Perthshire*: in *Annals of Scottish Natural History*, 1900: p. 168.
[6]Bentham and Hooker: *Handbook of the British Flora*: London, 1912: p. 168.
[7]Bentham and Hooker: *Handbook of the British Flora*: London, 1912: p. 168.
[8]G. C. Druce: *Notes on the Flora of Perthshire*: in *Annals of Scottish Natural History*, 1900: p. 165.

Den, I noticed a pure white one on several occasions during the winter 1920-21. Since 1922 few, if any, Starlings now roost there.

Countless thousands spend the night among the reeds fringing the Tay estuary, especially around Mugdrum and Cairnie Pier. If a shot be fired, the sound made by the host of birds as they rise from their sleeping-quarters is absolutely deafening.

Before 1925 the local Starlings seemed to be almost entirely single-brooded, but in that year I found at least nine second nests, while in 1926 fully half of them seemed to have second broods. Most of these were small, and many weak nestlings died.

Rosy Pastor, or Rose-Coloured Starling (Pastor roseus. L.) An adult male was shot at Invergowrie in October, 1925. This is the first specimen obtained since the Megginch female in 1846, although several are believed to have been seen at various times in the Carse of Gowrie. Both these specimens are in the Museum.

Hawfinch (Coccothraustes c. coccothraustes. L.) Several occurrences during 1925. An immature male was brought to me in a dying condition, June 24, picked up in Scone Palace gardens, while an adult male was found dead at Dupplin, March, and a third was shot by a boy with an airgun in the outskirts of Perth. A young one reported from Inchture, August, 1925 (Scot. Nat., 1926, p. 105).

Goldfinch (Carduelis c. britannica. Hartert). This beautiful finch is now increasing again in various parts of the county, being reported as quite numerous in one district, best left undefined. A pair almost certainly nested in the Parish of Scone in 1925, and possibly 1924, as the parents were repeatedly seen carrying food, but, despite diligent search, the nest was not found.

The Mealy Redpoll (Carduelis l. linaria. L.) has been seen in small numbers in the Bridge of Earn and Glenfarg districts during the late autumn and winter of both 1925 and 1926.

Tree-Sparrow (Passer m. montanus). Seen Milnfield, April, August, and October, 1924 (Scot. Nat., 1924, p. 112).

Reed-Bunting (Emberiza sch. schœniclus. L.) A great increase in the breeding stock was noticeable in 1925, this species appearing in several districts where not previously observed, and seeming to be more numerous than usual in the localities it previously frequented, especially in the Methven and Almondbank neighbourhoods. A slight diminution was apparent this summer (1926).

A LAPLAND BUNTING (Calcarius l. lapponicus. L.) was noted at Buddon Ness, September 14, 1925 (Scot. Nat., 1925, p. 72). This is the first record of this species for the Tay area.

WOOD-LARK (Lullula a. arborea. L.) One at Balcormie, East Fife, April 7, 1924, constitutes our first record, as well as the first for the Scottish mainland. One was seen near Dunkeld by Mr. H. A. Gilbert, June 17, 1925. Ornithologists should look out for this bird, which, I am inclined to think, is not so rare in Scotland as is supposed; it must be remembered that the Tree Pipit is locally called the Wood-Lark, which causes endless confusion when one tries to make inquiries.

SHORE-LARK (Eremophila alpestris flava. Gmelin.) Three reported on Tayport shore, January 7, 1924 (Scot. Nat., 1925, p. 75).

A BLUE-HEADED WAGTAIL (Motacilla f. flava) is said to have occurred at Elliot, Forfarshire, September 17, 1925 (Scot. Nat., 1926, p. 72). There is no previous record for "Tay."

The TREE-CREEPER (Certhia familiaris britannica. Ridgeway), the GREAT (Parus m. newtoni. Prazak), BLUE (P. c. obscurus. Prazak), COAL (P. ater britannicus. Sharp and Dresser), and LONG-TAILED (Ægithalos c. roseus. Blyth), as well as the GOLDCREST (Regulus r. anglorum. Hartert) all suffered very severely from the winter of 1916-17, only the Great Tit surviving in any numbers. All have now recovered, although the Blue and Coal Tits are still fewer than they used to be. The increase of Goldcrests and Tree-Creepers has been very noticeable during the last two to three years (1924-26).

The GREAT GREY SHRIKE (Lanius e. excubitor. L.) has occurred several times during the last twelve years.

WAXWING (Bombycilla garrulus. L.) Perthshire had its share of the great Waxwing invasion of five years ago, and since then single specimens have been seen at Kingoodie and in the outskirts of Perth.

PIED FLYCATCHER (Muscicapa h. hypoleuca. Pallos.) An adult male was seen near Aberfeldy in May, 1925. This is the first recorded for some years.

The CHIFFCHAFF (Phylloscopus c. collybita. Veillot.) The status of this bird requires elucidation. From 1917 to 1921 I used to hear and see one, sometimes two pairs, all summer in Scone Woods, but since then there has been neither sight nor sound of them. The bird is inconspicuous, but its note is quite unmistakable.

Most Warblers seem to be on the increase round Perth, especially the WILLOW-WARBLER (Ph. t. trochilus. L.) and SEDGE-WARBLER (Acrocephalus schœnobænus. L.) Information is required on the GRASSHOPPER-WARBLER (Locustella n. nævia. Boddaert) and WOOD-WARBLER (Ph. s. sibilatrix. Bechstein.) The local Willow-Warblers show an unusually strong tendency to nest in bushes.

SONG-THRUSH (Turdus ph. clarkei. Hartert.) In May, 1924, I found a Thrush's nest containing nine eggs. This number has been previously found, but very seldom, and has never been surpassed (Brit. Birds, XVIII., p. 219).

In 1920 a Cuckoo at Scone laid in a Thrush's nest.

CONTINENTAL SONG-THRUSH (T. ph. philomelus. Brehm.) Noticed in weather movements in East Fife in January, and two at Invergowrie, February 3, 1924. Probably often overlooked.

GREENLAND WHEATEAR (Œnanthe œ. leucorrhoa. Gmelin.) Occasional passage-migrant on coast; often overlooked.

DIPPER or WATER-OUSEL (Cinclus c. britannicus. Tschusi.) In January, 1924, just above the mouth of the Almond, I saw a Dipper hover several times, exactly like a Kestrel. It remained stationary in the air for more than ten seconds at a time, and seemed to be watching the shallow water for prey, just like a Hawk. I sent an account to British Birds (XVIII., p. 22), asking if anyone else had noticed such a performance, but received no reply at all.

SWALLOW (Hirundo r. rustica. L.) On September 20, 1924, and September 5, 1926, I ringed young Swallows at Scone, still in the nest.

HOUSE MARTIN (Delichon u. urbica. L.) The House Martin colony at Logiealmond Lodge turned up very early in 1926, and in reduced numbers. They had two, and in some cases only one brood, as against the normal, always two and often three broods. Martins frequented Errol Park this year (1926) until early November; up to twenty were seen together.

SWIFT (Apus a. apus. L.) There has been a noticeable shortage of Swifts round Scone in 1925 to 1926.

Green Woodpecker (Picus viridis virescen. Brehm.) This Woodpecker has occurred several times of late years. I myself saw one at Balboughty, October, 1912; one was found dead at Megginch in the winter of 1923; and others seen in the latter locality May, 1925, and September-October, 1926.

The Great Spotted Woodpecker (Dryobates m. anglicus. Hartert) continues to increase and spread as a breeding species.

The Cuckoo (Cuculus c. canorus. L.) was reported in "British Birds" this year as laying in West Perthshire at the unusually early date of May 3rd or 4th.

Tengmalm's Owl (Ægolius f. funereus. L.) The seventh of this species recorded in Scotland, and the first known in our area, was shot near Blairgowrie in February, 1915.

Golden Eagle (Aquila c. chrysaëtus. L.) An Eagle, believed to be the one which for more than a year had irregularly haunted the Logiealmond district, appeared near Almondbank in November, 1926, and stayed for a few days. It may be a slightly injured bird, or an "escape," as it showed little fear of man, and remained in a plantation while several hundred shots were fired at Pheasants within 200 yards!

Rough-Legged Buzzard (Buteo l. lagopus. Brünnick.) A specimen was obtained in the Blairgowrie neighbourhood in November, 1926.

Hen-Harrier (Circus c. cyaneus. L.) A pair attempted to nest in the Glenalmond district in 1921, but were destroyed in ignorance. Others have been seen from time to time (*e.g.*, Methven district, 1917, Logiealmond several times), and this Harrier would doubtless re-establish itself if given a chance. It is perfectly harmless.

The Kite (Milvus m. milvus. L.) I had the extraordinarily good fortune to see a pair of Kites on the Logiealmond hills in August, 1917. What happened to them I do not know. The Kite has been extinct in Scotland for many years, save as a very rare straggler.

Osprey (Pandion h. haliætus. L.) An Osprey visited Taymount about 26th April, 1924 (Scot. Nat., 1925, p. 75).

The Bittern (Botaurus s. stellaris. L.) Several occurrences of late years. Most recent, 2nd December, 1925, Tayport; December, 1925, Lake of Menteith ("Forth" area).

WHOOPER SWAN (Cygnus cygnus. L.) Reported to have bred in West Perthshire, 1919, and probably 1918. Formerly nested in the Orkneys, but the above is the first record of breeding in the British Isles for many years. Since then the Whooper is said to have nested in the Western Highlands, and in Northumberland. (Prac. Handbk. of Brit. Birds, Vol. II., pp. 229 and 899.)

The GREY LAG-GOOSE (Anser anser. L.) has nested once, perhaps twice, since the War in the Tay marshes. Probably one of the pair was a bird slightly wounded by some fowler, as the Grey Lag does not normally nest south of Loch Maree on the mainland. The Grey Lag, in company with hundreds of the PINK-FOOTED GOOSE (Anser brachyrhynchus. Baillon) frequents the Carse of Gowrie in vast gaggles from late September or early October until April, and sometimes May.

The WHITE-FRONTED GOOSE (Anser albifrons. Scopoli.) This Goose is a rare visitor to Perthshire. One was shot at Kinloch, Meigle, in January, 1919, and fowlers get an odd one every few years in the Carse of Gowrie.

The BEAN-GOOSE (Anser f. fabalis. Latham) was formerly fairly abundant, but for some years past has been but a rare straggler. More, however, have been noticed in the past two or three years, several having been shot in the Carse; while a gaggle of seven was observed on Mugdrum Island in 1925.

A SNOW-GOOSE, whether the LESSER (Anser hyperboreus hyperboreus. Pallos) or the GREATER (A. h. nivalis. Forster) is unknown, was watched at Tayport on the 11th of January, 1924. This would seem to be our first record.

The TEAL (Anas c. crecca. L.) seems to be on the increase, but would multiply still more rapidly were it not for the senseless slaughter that takes place annually on the 1st of August among the reed-beds of the Tay estuary; then large numbers of Teal, too young to fly, and useless alike for sport and eating, are shot, clubbed, and caught with dogs, or even by hand.

GARGANEY (Anas querquedula. L.) A specimen of this Duck, very rare in Scotland, was shot near Mugdrum Island, September, 1925. Two others were seen at the same time.

PINTAIL (Anas a. acuta. L.) nested Kingoodie, 1924.

The EIDER (Somateria m. mollissima. L.) is steadily increasing at Tents Muir, despite the attention of Hoodie

Crows and trousered vermin from Tayport and Dundee. Probably over one hundred nests are at Tents Muir every year.

A SMEW (Mergus albellus. L.) was shot in Montrose Basin, March 6 (!), 1925.

RED-NECKED GREBE (Podiceps g. griseigena. Boddaert.) I saw on Loch Earn in March, 1920.

STOCK-DOVE (Columba œnas. L.) steadily increasing.

TURTLE-DOVE (Streptopelia t. turtur. L.) About three in the last dozen years, including one, Meikleour, 1916, and one, Lynedoch, 1917.

LAPWING (Vanellus vanellus. L.) A Lapwing, with pure white wings, has frequented the same field, a few miles north of Perth, on and off for the last four years.

GREY PLOVERS (Squatarola s. squatarola. L.), TURNSTONES (Arenaria i. interpres. L.), SANDERLINGS (Crocethia alba. Pallos), KNOTS (Calidris c. canutus. L.), LITTLE STINTS (Calidris minuta. Leisler), GODWITS (Limosa l. lipponica. L. and L. l. limosa. L.), WHIMBRELS (Numenius ph. phæopus. L.), and other Waders are occasionally seen in the Tay estuary or on the Fife or Forfarshire coasts.

JACK SNIPE (Limnocryptes minimus. Brünnick) is quite common in the Tay reed-beds in winter, now and then even outnumbering the Common Snipe; in 1925 and 1926 I have seen more inland than for some years previously.

The WOODCOCK (Scolopax r. rusticola. L.) seems to be still increasing as a breeding species.

SANDWICH TERN (Sterna s. sandvicensis. Latham.) The Sandwich Tern breeds in fluctuating numbers on Tents Muir. In 1925 there were about 200 nests, but considerably fewer this year.

The ROSEATE TERN (S. d. dougalli. Montague) has been seen once or twice at Tents Muir; the LITTLE TERN (S. a. albifrons. Pallos) nests there in small numbers, as do a certain number of ARCTIC TERNS (S. macrura. Naumann) and several thousand COMMON TERNS (S. h. hirundo. L.)

LITTLE GULL (Larus minutus. Pallos.) Occasionally seen in autumn on coast. One stayed at Elliot, Forfarshire, from September 25, 1925, onwards, apparently throughout the winter. Others were seen there in 1924.

Iceland Gull (Larus glaucoides. Meyer.) One seen Elliot, Forfarshire, October 12, 1925.

Southern Guillemot (Uria aalge albionis. Witherby.) One, an immature bird, was caught in the Sma' Glen towards the end of September, 1926. It was brought alive to Perth Museum, "ringed," and released in the Tay; it swam quite happily away downstream.

Puffin (Fratercula a. grabae. Brehm.) An immature specimen, in a dying condition, was caught by a dog near Dunning, November 11, 1924. On dissection it proved to contain several kinds of trematode parasites; this appears to be the first time internal parasites have been found in the Puffin.

Land-Rail (Crex crex. L.) More numerous in 1926 round Scone than for several years.

Water-Rail (Rallus a. aquaticus. L.) Not uncommon in late autumn and winter in the Tay estuary. Occasionally a number inland in winter, as in 1916-17. Probably overlooked as a breeding species owing to its secretive habits.

Tetraou urogallus. L. × Lyrurus t. britannicus. Witherby and Lönberg. A very fine male specimen of Capercailzie-Blackgame hybrid was shot on Logiealmond, November, 1922.

Lagopus s. scoticus. Latham. × Phasianus colchicus. L. A hybrid Grouse-Pheasant was bred at Ballathie in 1924. It died soon after it was full-grown. I have never heard of this cross having taken place before.

Quail (Coturnix c. coturnix. L.) I saw one at Trinity Gask on two occasions, end of September and beginning of October, 1916. The keeper told me one or two were seen almost every year, and that he believed they still nested in Strathearn.

A male was got at Stanley, May 29, 1924, having apparently killed itself on some roadside telephone wires.

Red-Legged (or French) Partridge (Alectoris r. rufa. L.) Some turned down under the "Euston" system at Lynedoch have shown a remarkable hardiness. One shot in January, 1926, was in excellent condition, notwithstanding that the neighbourhood in which that particular covey lived had been covered for three weeks with snow from fifteen inches to two feet in depth, and had had to endure 10°-20° frost for many successive nights.

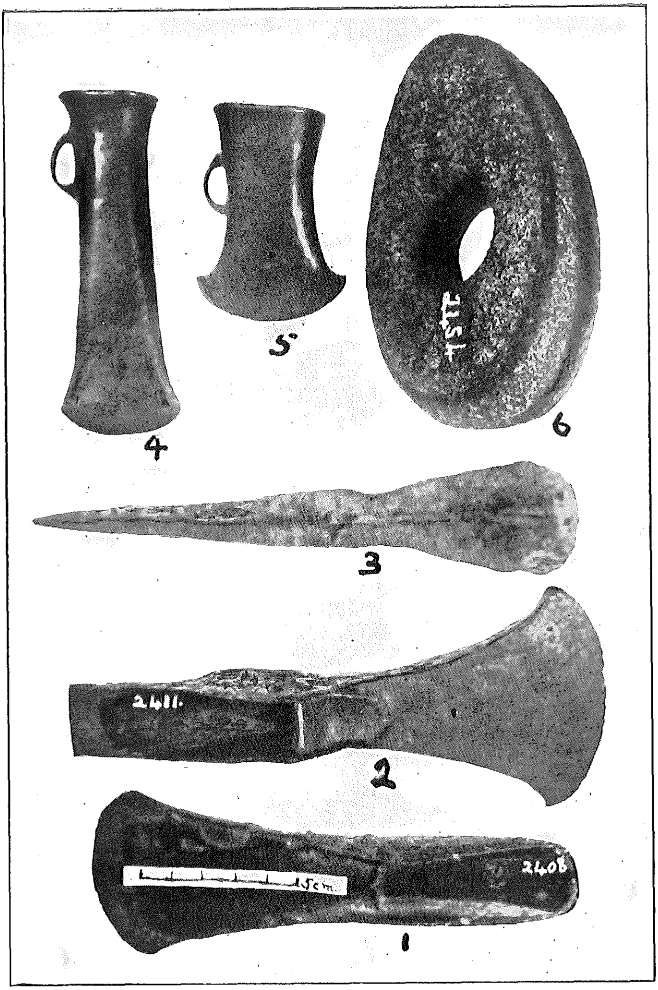


Plate 22.

		Museum No.
1.	Bronze Axe, Tullybeagles, - - - - -	A 2408.
2.	Bronze Axe, Dunning, - - - - -	A 2411.
3.	Bronze Dagger, Aird, Weem, - - - - -	A 2404.
4.	Bronze Axe, in River Tay, Delvine, - - -	A 2406.
5.	Bronze Axe, in River Tay, Luncarty - -	A 2407.
6.	Stone Hammer, Rossie Law, - - - - -	2454.

XII.—*Prehistoric Implements recently acquired by the Perth Museum.*

By J. GRAHAM CALLANDER, F.S.A.SCOT.,

Director of the National Museum of Antiquities of Scotland.

(Read, in the absence of Mr. Callander, by John Asher, F.S.A.Scot., 12th February, 1926.)

During the past few years quite a number of relics belonging to prehistoric times have been added to the collections in the Museum of the Perthshire Society of Natural Science, all having been found within the area to which the Society specially devotes its attention. This is all the more satisfactory because, at the best, the total number of objects dating to the Stone, Bronze, and Early Iron Ages recorded from Perthshire cannot be considered very large, when the wide area of habitable ground within the county is taken into consideration. Further, it is desirable that this department of the Museum should be developed. Nothing will help more to this end than a good representative display of the different kinds of antiquities which are to be found in the county, because it is only by seeing such objects and knowing what to look for that the ordinary worker on the land can be expected to understand what should be picked up.

Taking what we may consider the oldest relics first, there are four dressed flints from the Blairgowrie district, presented by Mr. Thomas Craig, Blairgowrie. One of these is an irregularly shaped discoidal scraper for dressing skins of animals (2437), and the other part of a core (2439) measuring $1\frac{5}{16}$ inch, and $\frac{1}{4}$ inch in greatest diameter respectively; the third (2438) is an end scraper, measuring $2\frac{1}{16}$ inches in length by $1\frac{11}{32}$ inches in greatest breadth; and the fourth (2440) is a rude knife narrowing towards one end and measuring $2\frac{21}{32}$ inches in length and $1\frac{5}{32}$ inch in greatest breadth. The first and third were found at Marlee, the second at Blairgowrie, and the fourth at Carsie. The number of flint implements in the Museum could be greatly increased if the ploughed land in the neighbourhood could be systematically searched during the next few weeks, as the winter rains and frosts tend to show up the flints on the surface.

Three stone axes fall to be noted. One (2527), a rather rude and weathered example, measuring 3 inches by $1\frac{9}{16}$ inch by $\frac{5}{8}$ inch, and weighing only $2\frac{1}{2}$ oz., was found at Garvock, Dunning, and was presented by the Rev. Neil Meldrum, late of Forteviot. The next (2249), which is rather thick for its length, and measures $4\frac{21}{32}$ inches by $2\frac{7}{32}$ inches by $1\frac{1}{2}$ inches, was found near Bridge of Earn and presented by Dr. Laing. The third (2528) is broken, as only the cutting end remains, and it now measures $4\frac{1}{2}$ inches by $2\frac{25}{32}$ inches by 2 inches; it was found in a heap of stones at Hoolmyre, adjoining Dunsinnan Hill, and was presented by Mr. Stewart, Balbeggie Hotel, through Mr. A. M. Scott. Though none of the axes can be considered a good specimen, the first is unusually small, and the third is interesting through having been used as a hammer-stone after it was broken and rendered useless as an axe. We have also to bear in mind that the record of a poor example is as important as that of a finer one when the pre-history of a district comes to be studied.

The flint implements and stone axes described probably belong to the Stone Age, but as such objects continued to be made and used in the Bronze Age, some of them may belong to the later period.

The next relic to be described (2454) is a perforated axe-hammer, which, though made of stone, no doubt belongs to the Bronze Age, as these objects have not infrequently been found in burial deposits belonging to this time in both Scotland and England. This example was found at the foot of a scaur on the north side of Rossie Law, Dunning, in November, 1923. It measures $4\frac{1}{2}$ inches in length, $2\frac{27}{32}$ inches in greatest breadth, $1\frac{1}{2}$ inches in thickness at the butt and opposite the perforation, and 2 inches at the sharp end; it is nearly flat on the under side, but has a distinct curve towards one end on the other. The perforation is countersunk from both sides, narrowing from $1\frac{7}{16}$ inch in diameter at the surface to $\frac{15}{16}$ inch at the centre. It is encircled round the middle of the sides by double rounded, raised mouldings, which are also continued round the narrow end, a feature, so far as I am aware, unique amongst such objects. Although the relic is much pitted by weathering, its peculiarity in having an ornamental moulding carried round the sharp end makes it of considerable importance in determining the use to which the small ornate axe-hammers of the Bronze Age were put. From the small size and ornamental forms of some of them, and because generally they show no signs of wear through cutting or hammering, it has long been considered that their purpose was ceremonial rather than industrial or war-like. The correctness of this opinion seems to be confirmed by the example from Rossie Law. If it had been meant for cutting, there was no excuse for carrying the moulding round the cutting end, and, like many others, it shows no abrasions through such use at this part.

Another object of stone (2452), which may belong to the Bronze Age, is the small neatly-made whetstone of bronze quartzite, found about twenty years ago at Leadkitty, Dunning, and presented recently by Mr. Fairweather. Of rectangular section attenuating from the centre towards the extremities, it measures $2\frac{3}{4}$ inches in length, $\frac{1}{2}$ inch by $\frac{13}{32}$ inch in thickness at the centre, tapering to about $\frac{5}{16}$ inch and $\frac{9}{32}$ inch at the ends.

Of Bronze implements one has been acquired by the Museum and four have been deposited on loan.

The earliest of these (2408) is a flat axe with flanges on the sides and a very faint indication of a stop-ridge, found on Tullybeagles Farm in 1891, and lent by Lady Violet Astor. It measures $6\frac{1}{8}$ inches in length, $2\frac{1}{4}$ inches across the cutting edge, and $\frac{29}{32}$ inch in width across the flanges. The next (2411) in point of age is a more fully developed flanged axe, which was found in digging a drain near Dunning, and lent by Dr. Forrest, Gynack, Auchterarder. It has wide flanges with a prominent stop-ridge between them, a wide crescentic cutting edge, and an ornamental curved rib-moulding in front of the stop-ridge. It measures $6\frac{5}{8}$ inches in length, $2\frac{27}{32}$ inches in breadth across the cutting edge, and $1\frac{17}{32}$ inches across the flanges; the stop ridge is $\frac{9}{16}$ inch in height on one side, and $\frac{19}{32}$ on the other side.

Belonging to the latter part of the Bronze Age are two socketed axes found in the bed of the Tay by pearl fishers, one at Delvine and the other at Luncarty; these are lent by Mr A. P. Lyle, of Glendelvine, Murthly. The first (2406) measures $4\frac{3}{32}$ inches in length, $1\frac{19}{32}$ inches across the cutting edge, and $1\frac{1}{4}$ inches in external diameter at the mouth of the socket, which is rounded. Below this, however, it becomes of octagonal form. The loop on its side is complete. The second axe (2407) is a more dumpy specimen, with an oval mouth to the socket, the ends of the cutting edge recurving slightly backwards, and a loop placed well down its side. It measures $2\frac{13}{16}$ inches in length, 2 inches across the cutting edge, and $1\frac{15}{32}$ inches by $1\frac{9}{32}$ inches across the mouth of the socket.

The last bronze object is a dagger (2404), measuring $6\frac{7}{8}$ inches in length, $1\frac{15}{32}$ inches in width across the butt, and $\frac{9}{32}$ inch in thickness at the centre. This object is in poor condition, as there are no indications of the rivet holes, with which it was probably provided, to fix it to the haft, and the edge is corroded away in parts. It is of a simple narrow triangular shape, thickened at the centre and tapering off to the sides and point. Although the weapon may not be in good condition, the record is interesting, as it belongs to a class of objects not very numerous in Scotland. It was found in October, 1923, stuck into the ground with one-half appearing above the surface, at Aird, above Castle Menzies, parish of Weem.

The remaining objects to be noted are made of stone, and probably belong to later times than those we have been discussing. Their period, however, cannot be stated with any degree of exactitude. The first (2457) is a cylindrical pounder of oval section found in a field at Glenalmond, and presented by Mr William McLagan. It is abraded by use at both ends, and measures 6 inches in length by $1\frac{13}{16}$ inches and $1\frac{5}{16}$ inches in cross diameters at the centre. Hammer-stones and pounders belong to many periods, as they were used from the earliest times. They have been recovered from Scottish sites dating to Azilian times. Many have been found in our hill forts, brochs and earth-houses, which were occupied in the early part of the Christian era. The second object (2297) is a flattened water-worn stone, with a small perforation near one end, which is rounded, the other being roughly square across; it was found near a mound at Murie, Errol, and presented by Mr. David Smith. It measures $2\frac{23}{32}$ inches by $1\frac{5}{16}$ inch by $\frac{15}{32}$ inch. The period to which it belongs cannot be stated, and it may have been used as a whetstone or sinker. Next there are two roughly oval discoidal stones with a perforation counter-sunk from both sides near the centre, and one with a second hole between that in the centre and one end of the stone. The first (2458), presented by Mr. K. H. Garvie, Murrayfield, Crieff, and found in the donor's garden, measures 4 inches by $2\frac{11}{16}$ inches by $1\frac{5}{16}$ inch, the perforation being $\frac{9}{16}$ inch in diameter at the narrowest part. The second (2443), from Marlee, Blairgowrie, and presented by Mr. Thomas Craig, measures $4\frac{7}{32}$ inches by $3\frac{3}{4}$ inches by $\frac{5}{8}$ inch, the perforation being $\frac{7}{16}$ inch at its narrowest part. The remaining one, that with the two perforations (2237), measures 5 inches by $3\frac{9}{16}$ inches by $1\frac{1}{2}$ inch, the central perforation being $\frac{17}{32}$ inch in diameter and the other $\frac{5}{16}$ inch at the narrowest part. This stone was found at the back of the garden at Methven Castle, and presented by Colonel Smythe. Perforated stones such as these described and others of smaller dimensions have been found in large numbers in Aberdeenshire, but we have still to find out to what use they were put. A few have been found in sites inhabited during the first few centuries of this era in different parts of the country. The round flattened stone with a worked hollow on the top $\frac{1}{4}$ inch in diameter and $\frac{1}{8}$ inch deep has been split longitudinally. It was found in a field at Leadkitty Dunning, and was presented by Mr. Fairweather. It looks like a small anvil stone, but when complete it may have had a similar hollow on the opposite side. It measures $2\frac{13}{16}$ inches in diameter and 1 inch in thickness, being flat on the under side and domed on the top (2453).

Plate 23. Celtic Bell, found at Newburgh,
13th January, 1926.
[" *Bulletin* " *Photo.*

There now remain only two objects to be described. One is a spinning whorl of circular section ornamented with scrolls, and measuring $1\frac{1}{16}$ inch in diameter by $\frac{1}{4}$ inch in thickness, the perforation being $\frac{3}{8}$ inch in diameter; it was found on the North Inch at the Boat Jetty amongst rubbish containing bones and earth. Its period cannot be stated, as whorls were used in Scotland from prehistoric times down into the nineteenth century. The other relic is an oval water-worn stone (2699), of slightly oval section encircled with a shallow groove; it varies between $\frac{9}{16}$ to $\frac{11}{16}$ inch in breadth, and is $\frac{7}{32}$ inch deep round the centre, and abraded at one end. It was found at Mains of Fordie, and presented a fortnight ago by Mr. W. H. Cox, of Snaigow. It measures $4\frac{13}{32}$ inches in length by $2\frac{1}{32}$ inches, and $\frac{9}{32}$ inch in cross diameters near the middle. It is difficult to say what was the original purpose of this stone or its date. Heavy stones marked with a groove and used as mauls are well known in some countries, and even stone axes show this feature. The abrasions on one end of the Fordie example show that it has been used as a hammer, but this may have been a late use, as it is to be remembered that stones like this were sometimes made as sink stones for nets.

XIII.—*Note on a Celtic Bell found at Mares Craig, near Newburgh.*

By Robert R. B. Watson.

(Read 12th February, 1926.)

It falls to me to make a few notes on the Celtic Church Bell which has been shown to-night, and which was got from the quarry at Mares Craig, about a mile beyond Newburgh.

I shall deal with the find and the locality, leaving the more important matter of thanks to those concerned in the finding and the bringing of the same under the notice of the Society to the end of my notes, where they are less likely to be overlooked and forgotten.

The quarry lies in the line between Lindores Abbey and Lindores Loch, about $\frac{1}{2}$ mile beyond junction of the Lindores Abbey Road and the present Newburgh-Cupar Road, almost due east of Clatchard Craig. The old road ran to the east of the Mares Craig with a few cottar houses called Remalton.

(See Small's Antiquities of Fife, p. 220.) Small speaks of the view of the Craig from Clatchard as showing the outline of fortification which he puts down as a Roman outpost. There is no sign on the Craig of any made-up fortification, and what looks like walling is natural rock. Unfortunately I have no knowledge of the original features of the Craig, but from the O.S. 6″ map it seems to have been roughly of a figure 8 shape lying nearly north and south. The quarrying has cut away all the westerly part of the hill, so that now it has the form of a B with a clean cut cliff facing west. For the purpose of throwing down a fresh section Mr. Bell was clearing off the soil, and just about the waist of the 8 on the north slope they came upon a small mound composed of broken stone and soil. When clearing this away some cut stones were noticed and set aside, also much carbonized wood or charcoal, broken pieces of bone, and the bell now before you. There was also a stone with a worked hole about halfway through, what, but for the nature of the stone, might suggest a pivot stone. Unfortunately there was little left in situ by the time we got back, and, as the pile stood within two feet of the edge of the cliff, it was hardly attractive on a frosty morning for close inspection. The dressed stones seem to have been worked with a hand pick, and, though a considerable quantity of lime mortar was found in the heap, there is no trace of it on any of the stones. From the size of the pieces of carbonized wood it looks as if the colour, etc., was due to length of burial rather than fire; some pieces were about 6 inches long and dressed about $4 \times 2\frac{1}{2}$.

The Bell, which seems to be of the older Celtic type, is of iron, and seems, like others, to have been coated both inside and out with bronze. The handle is gone, and from the fact that a sharp-pointed nail still sticks through from the outside may have been mended by having a piece of wood inserted inside; the handle seems to have been set on about 1 inch from either end, and not the full length of the Bell.

The Bell measures:—

Height, $6\frac{3}{8}$ inches; width at mouth, $5\frac{3}{4} \times 3\frac{1}{4}$; width at top, 5. The width of the mouth is not even, being $3\frac{3}{4}$ at one end and 3 inches full at the other.

There was some talk, afterwards confirmed, that some time before a skull had been got, but unfortunately had gone the way of many other things and been tipped into the clearance dump.

I would ask the Society to accord to Mr. Bell, the quarry-master, their sincere thanks for his most generous placing of the Bell and Socket Stone in our Museum Collection. I would also desire to put on record their appreciation of Provost Anderson's interest and help in the matter.

May I say that from a report given in the Proceedings of

Scot. Ant. in Vol. 44, p. 274, at that time only 9 Celtic Bells of iron were known then in Scotland.

In addition to the previous list of finds on Mares Craig another worked stone of balsaltic rock from the same place has, through the good offices of Mr. Bell, been brought under notice. This is a perforated stone, measuring in its greatest diameter $3\frac{1}{8}$ inches × (least) $2\frac{3}{4}$ inches × $1\frac{7}{32}$ inch thick. The stone, which is volcanic, has been perforated by picking from the two sides; meets in centre in a hole of $\frac{7}{16}$ inch, and is remarkable for the exactitude of centreing. There has been no clearing of medial meeting line by boring or wear. Weight of stone, $\frac{1}{2}$ lb.

For References to Scottish Bells.

See Proceedings of Scot. Antiq., Vol. I., p. 18-22—Where the Strowan Bell shows much similarity to this Newburgh Bell. p. 54—The Guthrie Bell. Vol. VIII., p. 265-276. See also Prehistoric Annals of Scotland, p. 654-664. In Proceedings of Scot. Antiq., Vol. XII., p. 138, mention of removal of Bell along with Stone of Destiny from Scone by Edward I. Vol. XIV., p. 102-108 is mention of bells at Glenlyon, Fortingall, and Inch (or Insh). The Glenlyon Bell is said to be Iron—no details given. Fortingall is said to be Iron dipped in Bronze. Size, 9 inches high × 6 × $7\frac{3}{4}$, rivetted up sides. Handle said to be " in two pieces soldered together." The analysis says:—It seems to be composed of an inner layer of Iron coated on both surfaces with Bronze (p. 104). Inch (or Insh) Bell—Cast Bronze, closely resembles Bell of St. Fillan, Glendochart. Size, 10 inches high × 8 × 5. Vol. XXIII., p. 118, gives Bell of Little Dunkeld. This is a Bronze Bell—cast; handle has had a flaw in casting and repaired by burning in. Height of body, 7 inches; mouth, $7\frac{1}{4}$ × $6\frac{1}{4}$—$3\frac{1}{2}$ × $2\frac{1}{2}$ at top. Vol. XIII., p. 346—Bell of St. Fillan, Struan. Shows illustration. Made of Iron. Height of body, $10\frac{1}{2}$ inches; handle, 3 inches; mouth, 7 × 6; top, $4\frac{1}{2}$ × $1\frac{1}{2}$. This and the one at Glenlyon are here said to be the only Iron Bells in their original locality—for comparison there is also an illustration of the Kingoldrum Bell (p. 346). In Vol. XXVI., p. 434, is reference to Forteviot Bell. This is a Bronze Bell, and the fifth of the Bronze Celtic Bells. In Vol. XXIV., p. 146, a similar Iron, dipped in Bronze, Bell, rivetted up sides, is quoted as from Bishampton, Worcester. In this case it is noted that the handle had been broken off and a wooden one substituted, " fastened by two large nails put through the top of the Bell " (compare this with the Newburgh Bell). Vol. XLIV., p. 274—Footnote mentions that 9 Celtic Bells of Iron and 3 of Bronze are preserved in Scotland, and illustrated in Scotland in early Christian times, p. 167-213; and that another

Bronze Bell is noted in Vol. XXIII. (of Proceedings), p. 118. Vol. LII., p. 163, is reference to Quadrangular Bell of St. Laurence at Edzell. See also Kilmichael Glassery. Argyll Bell shown in plate of Archæologia Scotica, Vol. IV., p. 1, plate 9. The Kelso Bell, which is peculiar in being got so far south and of which details are given in The Berwickshire Naturalists, 1882-1884, p. 184-191, also in Proceedings of Scot. Antiq., Vol. XVI., p. 277. This Bell was got at Ednam. It stands (without handle) 11 inches, and measures $6\frac{1}{4} \times 3$ at top. The handle is 2 inches high and $4\frac{3}{4}$ inches long and 1 inch wide. The mouth measures $8 \times 6\frac{1}{2}$ inches, and weighs 13 lb. 8 oz. In the reference in Vol. I. of Proceedings of Scot. Antiq. mention is made that "there are 16 or 17 such Bells." But only this one so far south. In Vol. XVI. of Proceedings, p. 153-154, is mention of small Iron Bell, $3\frac{1}{2}$ inches high $\times 2\frac{1}{4} \times 1$ at top and $3\frac{3}{4} \times 1\frac{1}{4}$ at mouth, said to have been got in Perthshire (but not localised), no trace of having been coated or dipped in bronze. Doubtful if ecclesiastical.

XIV.—*List of Coniferae in Ochtertyre.*

By JOHN W. KIPPEN, Tayport.

(Read 12th February, 1926.)

No.	Species.	Needles.	Name.	Native Habitat.
1.	Pinus Cembra	(5)	Swiss Stone Pine or Arolla Pine	Alps.
2.	Pinus Excelsa	(5)	Himalayan Pine	Himalayas.
3.	Pinus Laricio	(2)	Corsican Pine	Southern Europe.
4.	*var.* Austriaca	(2)	Black Austrian Pine	Austria.
5.	Pinus Montana	(2)	Mountain Pine	Central Europe.
6.	Pinus Parviflora	(5)	Japanese Short-leaved Pine	Japan.
7.	Pinus Pentaphylla	(5)	Japanese Weymouth Pine	Japan.
8.	Pinus Peuke	(5)	—— ——	Balkans.
9.	Pinus Ponderosa	(3)	Yellow Pine	North America.
10.	Pinus Strobus	(5)	Weymouth or White Pine	Eastern States of North America.
11.	Pinus Sylvestris	(2)	Scots Pine	Native.
12.	*var.* Aurea	(2)	Golden Scots Pine	Native.
13.	Abies Amabilis		Lovely Fir	Western States of North America.
14.	Abies Cephalonica		Greek Fir	Greece.
15.	Abies Lowiana		Colorado Silver Fir	West of the Rocky Mountains.
16.	Abies Firma		Japanese Silver Fir	Japan.

No.	Species. Needles.	Name.	Native Habitat.
17.	Abies Grandis	Tall Silver Fir	Western States of North America.
18.	Abies Brachyphylla or Homolepis	Nikko Silver Fir	Japan.
19.	Abies Magnifica	American Red Fir	West of the Rocky Mountains.
20.	Abies Nobilis	Noble Silver Fir	Western States of North America
21.	Abies Nordmanniana	Nordmann's Silver Fir	Caucasus.
22.	Abies Pectinata	Common Silver Fir	Central Europe
23.	Abies Pinsapo	Spanish Fir or Bottle Washer	Spain
24.	Abies Sachaleinensis	Saghalien Silver Fir	Saghalien.
25.	Abies Cilicia	Cilician Fir	Asia Minor.
26.	Picea Ajanensis	Yesso Fir	Japan.
27.	Picea Alba	White Spruce	North America.
28.	Picea Alcockiana	Alcock's Spruce	Japan.
29.	Picea Engelmanni	Engelmann's Spruce	Rocky Mountains.
30.	Picea Excelsa	Common or Norway Spruce	Europe.
31.	*var.* Clanbrasiliana	Dwarf	
32.	*var.* Finedonensis	Yellow	
33.	Picea Nigra	Black Spruce	North America.
34.	Picea Ormorica	Servian Spruce	Balkans.
35.	Picea Orientalis	Eastern Spruce	Caucasus.
36.	Picea Polita	Prickly Spruce or Tiger's Tail	Japan.
37.	Picea Pungens	Blue Spruce	Rocky Mountains.
38.	*var.* Pungens Glauca	Blue Spruce	Rocky Mountains.
39.	Picea Menziesü or Stitchensis	Menzies' Spruce or Sitka Spruce	West of the Rocky Mountains.
40.	Picea Smithiana or Morinda	Himalayan Spruce	Himalayas.
41.	Tsuga Albertiana	Prince Albert's Hemlock Spruce	Western States of North America.
42.	Tsuga Canadensis *var.* Nana	Canadian Hemlock Spruce (weeping)	Eastern States of North America.
43.	Tsuga Pattoniana	Patton's Hemlock Spruce	West of the Rocky Mountains.
44.	Tsuga Hookeriana	Hooker's Hemlock Spruce	Western States of North America.
45.	Tsuga Sieboldii	Japanese Hemlock Spruce	Japan.
46.	Abieta Douglastii (a) *var.* Glauca	Douglas Fir	Western States of North America.
47.	*var.* Stairii	Douglas Fir	Castle Kennedy.
48.	*var.* Aurea	(Golden)	
49.	*var.* Brevifolia	(Short-leaved)	
50.	Cedrus Atlantica	Atlas Cedar	Algeria.
51.	*var.* Argentea	Silvery Atlas Cedar	Algeria.
52.	Cedrus Deodara	Deodar or Indian Cedar	Himalayas.
53.	Cedrus Libani	Cedar of Lebanon	Mount Lebanon.
54.	Sciadopitys Verticillata	Umbrella Pine	Japan
55.	Torreya Nucifera	Japanese Stinking Yew	Japan.
56.	Torreya Taxifolia	American Stinking Yew	Eastern States of North America.

No.	Species.	Needles.	Name.	Native Habitat.
57.	Saxegothæa Conspicua		Prince Albert's Yew	Chili.
58.	Cunninghamia Sinensis			China.
59.	Libocedrus Decurrens		Californian Incense Cedar	Western States of North America.
60.	Sequoia Sempervirens		Redwood	Coast of California.
61.	Sequoia Wellingtonia or Wellingtonia Gigantea		Wellington Pine	Sierra Nevada.
62.	Ginkgo Biloba		Maidenhair Tree	Japan.
63.	Cupressus Lawsoniana		Lawson's Cypress	North America.
	(a) *var.* erecta viridis			
	(b) *var.* erecta			
	(c) *var.* argentea			
	(d) *var.* patula			
	(e) *var.* Fraseri			
	(f) *var.* Aurea-variegata			
	(g) *var.* alba-variegata			
	(h) *var.* Bowleri			
	(i) *var.* alba-pendula			
	(j) *var.* lutea			
	(k) *var.* alba-spica			
	(l) *var.* intertexta			
	(m) *var.* alba-spica nama			
	(n) *var.* ericoides			
	(o) *var.* filiformis			
	(p) *var.* Shawii			
	(q) *var.* gracilis			
64.	Cupressus Nootkatensis		Nootka Sound Cypress	Nootka Sound, British Columbia.
	(a) *var.* Aurea			
	(b) *var.* compacta			
	(c) *var.* glauca			
	(d) *var.* alba-spica			
65.	Cupressus Pisifera		Pea-fruited Cypress	Japan.
	(a) *var.* plumosa			
	(b) *var.* squarrosa			
	(c) *var.* plumosa-alba-picta			
66.	Cupressus Thyoides		White Cedar	Eastern States of North America.
	(a) *var.* glauca			
	(b) *var.* aurea			
	(c) *var.* leptoclada			
67.	Cupressus Arizonica			Arizona.
68.	Thuja Gigantea		Common Arbor Vitae	Western America
69.	Thuja Japonica		Japanese Arbor Vitae	Japan.

No.	Species. Needles.	Name.	Native Habitat.
70.	Thuja Occidentalis	Western Arbor Vitae.	Eastern States of North America.
	(a) *var.* plicata		
	(b) *var.* plicata-aurea		
	(c) *var.* vervaeneana		
	(d) *var.* Warreana		
	(e) *var.* elegantissima		
	(f) *var.* Ellwangeriana		
71.	Thuja Dolabrata	Japanese Thuja	Japan.
	(a) *var.* variegata		
	(b) *var.* laetevirens		
72.	Cryptomeria Japonica	Japan Cedar	Japan.
	(a) *var.* nana		
	(b) *var.* spiralis		
	(c) *var.* Lobbii		
	(d) *var.* elegans		
73.	Juniperus Communis	Common Juniper	Europe.
74.	Juniperus Chinensis	Chinese Juniper	China
75.	Juniperus Recurva		Himalayas.
76.	Juniperus Sabina	Savin's Juniper	Southern Europe.
77.	Juniperus Virginiana	Red Cedar	Eastern States of North America

XV.—*Note on Inula conyza, D.C., found on Kinnoull Hill.*

By David Campbell.

(Read 12th February, 1926.)

Walking on Kinnoull Hill one Sunday in October, 1924, I came upon a patch of what I at first took to be ragwort (Senecio Jacobæa. L.), but on closer inspection I found that it was a plant quite new to me. I took specimens home, and found it to be Ploughman's Spikenard (Inula Conyza, D.C.). Though confined to one spot, it was abundant, and covered a considerable area of ground. It was too late to get good specimens in flower, but in September last year I gathered several for the Herbarium. I mentioned my find to Mr. Menzies, who informed me that he had found this plant in the same spot over twenty years ago, so that it is well established. It would be interesting to know how and when the plant was originally introduced there.

XVI.—*Note on Lichens at Ardchullarie.*

By James Menzies.

(Read 12th February, 1926.)

Amongst a good many of the Commoner Lichens that were noted growing on old Ash trees at Ardchullarie; the following interesting species were found:—

Leptogium lacerum, S. F. Gray.
Sticta limbata, Ash.
Lobaria pulmonaria, Hoffm.
Perthusaria Wulfenii, D.C.
Normandina pulchella, Cromb.

XVII.—*Note on Coccidiosis of Brown Hare (Lepus europæus) in 1925.*

By J. Ritchie, F.R.A.I.

(Read 12th February, 1926.)

Reports had reached me that there seemed to be a heavy mortality among the Brown Hares in several localities throughout the County of Perth, the districts reported being Trinity Gask, Dupplin, Scone, and Logiealmond. The hares in the field were observed during the month of September to have become emaciated, with a general weakness in the hind quarters, and were easily caught alive. At the beginning of October a specimen was brought to the Museum. Examination gave negative results as to external parasites, there being no traces of either mites, fleas, or lice.

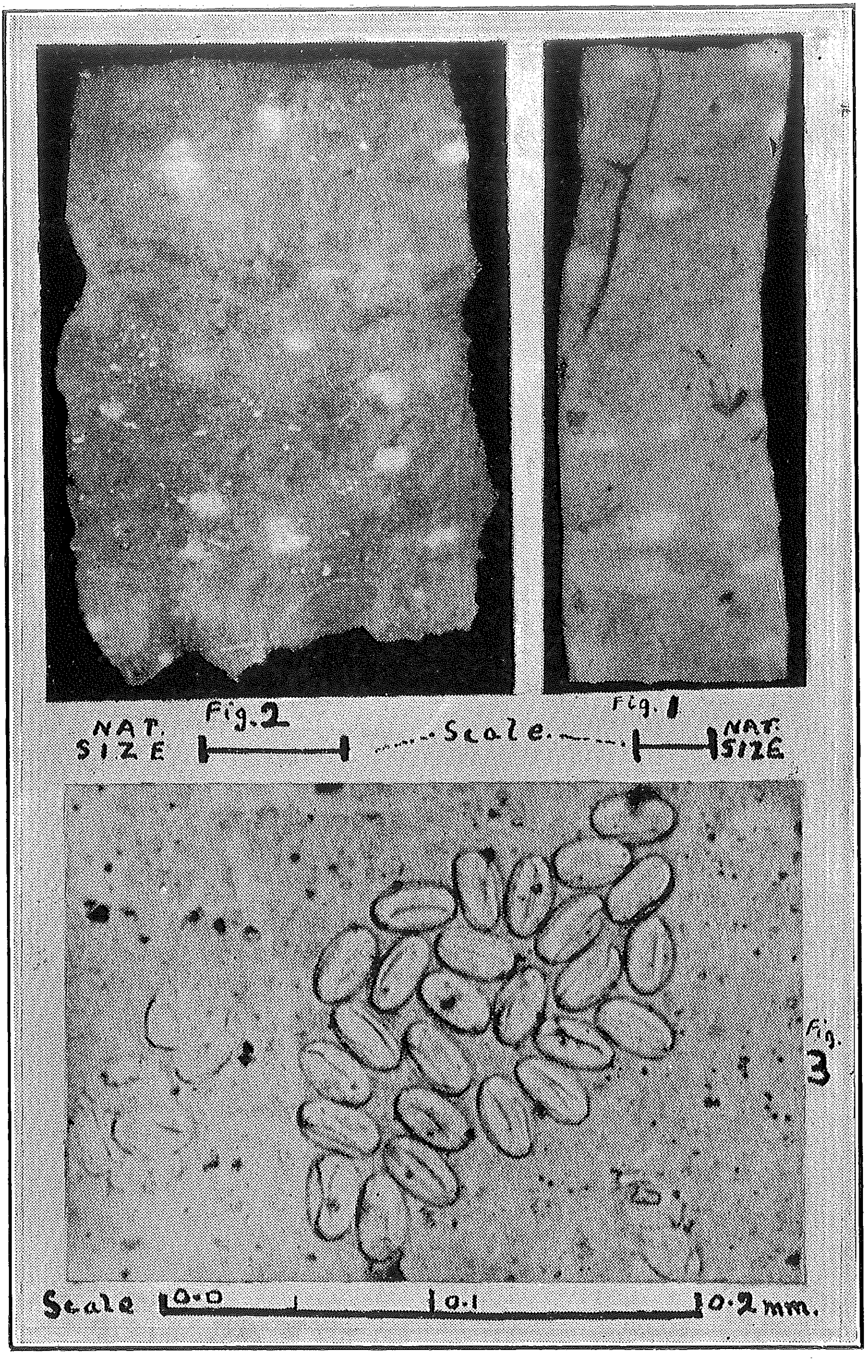


Plate 24. Coccidiosis of Brown Hare.

It was noted that, when opened, the blood vessels of the alimentary canal were congested and inflamed, while along the whole length between the duodenum and the rectum there were numerous small white patches (Fig. I.). Opening the intestine, it was found to be full of food, most of it being in an undigested condition. Washing out the food content revealed numerous lesions where the mucus membrane and the intestinal villi had been completely stripped off; at the points where the white patches showed up on the outside were small nodules mostly showing red and inflamed surfaces (Fig. II.). Smears of these showed broken down villi, blood corpuscles, and coccidiæ in the sporogany stage. Fig. III. shows part of one of these pustules which was taken and pressed out between glass slips and shows the coccidia in groups; microscopic sections of these pustules showed that the lesions penetrated right down to the muscular layers of the intestine.

By the end of December reports were much better from the localities where this weak condition of hares had been noticed, and that hares observed were in a normal condition, but fewer in numbers. One hare brought into the Museum in December on examination showed signs of healing in the intestine where there had been lesions.

In the course of the examination of both these hares particular notice was taken to see if there were any traces of any of the vermes parasites, nemotode, trematode, or tapeworm, but no traces of any of these parasites were seen.

Lichens: With Notes on Local Species.

Presidential Address.

By JAMES MENZIES.

(Read 12th November, 1926.)

The subject which I purpose bringing before you this evening is that rather unpopular branch of botany, the Lichens. I have chosen this subject because, in a certain sense, it is a new one. As you are all aware, these plants have received little attention from the members of our Society, and that, too, in a county perhaps unequalled in Britain for the wealth of its Lichen Flora. Nevertheless, I approach the subject with diffidence, both as to my ability to deal with it in such a manner as will make it intelligible to you, who presumably have little knowledge of these curious plants, and also because with the limited time at my disposal I must necessarily pass over many features of great interest regarding them.

Lichens are a class of plants distinguished from all others by their dual organisation, consisting of an Algae and a Fungus, living together, and deriving mutual benefit from this association. They are the most widely distributed of all plants, their peculiar organisation enabling them to live under the most diverse conditions and to endure extremes of temperature and prolonged desiccation which would be fatal to the higher vegetation. Lichens are found from the sea shore to the summits of lofty mountains, where they form the last outposts of vegetation. They are abundant in tropical and sub-tropical countries, and also cover vast tracts in the Arctic regions. Although some species seem indifferent to climatic conditions, and the nature of their substrata, yet they are influenced in their distribution by temperature, humidity, and the mineralogical character of the rocks. Thus some species are never found far from the sea, others only at high mountain altitudes. Some Lichens favour volcanic rocks, others sandstone, and a large number prefer limestone rocks and the mortar of old walls. Of those occurring on trees, certain species are only found on smooth bark, others preferring the rough bark of oak, elm, and ash. Lichens are also found growing on the ground, choosing soils of varying composition, others are found associated with mosses, and a number are parasitic on other Lichens. These plants, too, are sometimes found growing on such unlikely substances as iron, glass, bricks, leather, and charcoal, but no species is limited to these substances.

Although Lichens are often confounded in the popular mind with the mosses, yet most people are familiar with the Lichens appearing as stains or blotches on rocks and walls or enveloping the trunks of trees with a close leaf-like covering, or with short upright or pendulous growths, which sometimes extend even to the tips of the branches, giving the trees a weird aspect when they are abundant, as in some of our Highland forests.

In the Lichen plant there is no differentiation into root, shoot or leaf, such as we are familiar with in the higher vegetation, but the growth is termed a Thallus. The thallus is characterised by certain modes of growth by which these plants are described as Crustaceous, Foliose, or Fruticose. The crustaceous forms are by far the most numerous, appearing as crusts of varying thickness on the supporting rock or tree, to which they adhere so firmly that they cannot be removed without injury. Increasing by marginal growth from a common centre, the rate of increase is seldom maintained equally at the circumference, and thus they are often eccentric. In colour they are white, grey, reddish, brown, or various shades of yellow, the surface chalky, rough, friable, or warted.

A number of these Lichens are of very common occurrence around Perth, some species only affecting the andesitic rocks, other restricted to the sandstone, while a number are indifferent, being found on both formations. Our illustration shows part of a rock surface well covered with the thalline growths of **Lecanora Sordida** Th. Fr., a plant abundant on the rocks of the Sidlaws, which even enters the town at Craigie Knowes with **Lecanora muralis** Schaer; **Lecidea coarctata,** var. **glebulosa** Cromb; and **Lecidea confluens** Ach. **Lecanora galactina** Ach. is plentiful on plastered walls in the suburbs, and **Buella myriocarpa** Mudd. is not infrequent on trees at the South Inch. Further afield on the andesitic rocks we meet with **Haemattonia coccineum** Koerb., **Leaconra** (Asp) **gibbosa** Nyl., **Diplochistis scruposus** Norm., **Placodium ferrugineum** var. **festivum** A.L.Sm., **Rhizocarpun converviodes** DC., and **Rhizorcarpun geographum** DC. On the dry stone dykes of the sandstone area **Lecanora campestris** B. de Lesd. and **Rhizocarpun petreaum** Massel. are common, the latter being particularly fine in the old Letham quarries. **Lecanora parella** Ach. and **Lecanora atra** Ach., while not confined to the sandstone, are very abundant, the first-named growing to a large size, often covering the walls and forming an unbroken sequence for many yards. On trees also a number of these common Lichens are found. **Lecanora subfusca** Ach., **Lecanora varia** Ach., **Lecidea parasema** Ach., **Perthusaria communis** DC., **Arthonia radiata** Ach., and **Lecidea granulosa** Schaer is frequently found growing on bare or mossy soil.

The Foliaceous Lichens, as the title indicates, are leaf-like growths of one or more lobes, which may be broad and entire, deeply incised, or narrow and much branched, or variously lacerated, notiched, or irregular at the margin. They are closely adpressed to the substratum, to which they are usually attached by root-like processes, termed rhizoids. In this section also many common Lichens are found, **Parmelia saxatilis** Ach. on rocks and walls in favourable situations covering the coping stones of the dry stone dykes with a continuous crust. **Parmelia syphodes** Ach. is even more common on trees, heather stems, and on the ground. **Physica caesia** Nyl. on standstone walls and stones and **Xanthoria parietina** Th. Fr. is conspicuous everywhere by its bright yellow thallus. **Peltigera canina** Willd. and **Peltigera polydactyla** Hoffm. are frequent in open woods and on shady banks. **Everma prunastri** Ach., **Physica purverulenta** Nyl., and **Cetriaria glauca** Ach. are found on trees.

The Fruticose Lichens are shrub-like growths, usually much branched, short and upright, or long and pendulous. Many of them grow on trees, to which they are attached by a basil point or disc. **Ramalina fraxinea** Ach. is a well-known plant which, as its specific name indicates, shows a marked partiality for the trunks of ash trees. The plant is not common in East Perthshire, and I have only seen it in quantity near Kirkmichael. **Ramalina fastigiata** Ach. is a little more abundant, and **Ramalina farinacea** Ach. is a common plant. **Usnea florida** Web., well known as the old man's beard lichen, is not uncommon, and the black hair-like wisps of **Alectoria jubata** Ach. are often conspicuous on the trunks of fir trees. Associated with the fruticose lichens in their habit of growth, the **Cladonias,** or cup mosses, are an interesting family, social in their habits, growing on the ground in open woods, moors, and mountains, or peaty or heathy soil, although some species show a marked partiality for decayed wood and bark. These lichens appear primarily on the substratum either as crusts composed of minute scales, or of larger leaf-like growths, which are often incised or crenate at the margins. From these arise secondary forms, termed podetia, which vary a good deal in morphological characters. They may be short, upright, and pointed, or they may gradually widen upwards into a cup or chalice-like form, termed a scyphus, which bears the small fruit bodies around the margin. A number of these Cladonias are common lichens, some of which are shown in the illustration. **Cladonia pyxidata** Hoffm. is a plant of wide distribution, often admired for the neat elegance of its form. **Cladonia**

coccifera Willd. and **Cladonia flabelliformis** are conspicuous on our hills by their red fruits. **Cladonia rangiformis** Web. produces no scyphi. The plant grows in close tufts, branched or forked at the apices. In the sub-genus **Cladina** the plants are usually taller, and much branched. To this division belongs the famous reindeer moss, which covers vast tracts in Northern Europe. Dr. Macmillan, in "First Forms of Vegetation," thus describes the plant as he saw it in Norway:— "When in Norway, several years ago, I saw a herd of reindeer feeding on the reindeer moss on the summit of the Dourefjield mountains. The lichen presented a different appearance from the variety which grows in this country. It formed immense consistent masses, nearly a foot in depth, of a beautiful cream colour, and of wonderful elasticity, springing up when the foot sank in it up to the ankle. The plants are exceedingly beautiful, rich and intricately branched. There are three distinct varieties seen in Norway, and, like all lichens and Alpine plants, it becomes more luxuriant and lovely the higher it ranges."

The true reindeer moss, **Cladonia rangiferina** Web. occurs sparingly on our own mountains, and a closely allied species, **Cladonia sylvatica** Hoffm., is common at quite low elevations, colonies of it occurring on the hills around Perth.

As we have already mentioned, Lichens differ profoundly from all other vegetation in their composite organisation. They are composed of a fungus tissue of pale tubular threads, termed hyphæ, enclosing, and growing around, Algæ, minute plants possessing Chlorophyll. These Algæ can be identified occurring free in nature, quite apart from any association with fungi. The species which form an alliance with fungi are not numerous, but the same species are capable of entering into partnership with many very different lichen fungi. I shall only trouble you by a brief mention of three of these Algæ which are of frequent occurrence in this alliance. **Protoccus vulgaris** forms a green coating on trees and other objects, conspicuous in wet weather, the plant consisting of a simple cell. Multiplication takes place by division into two or four daughter cells, which become independent. Rejuvenation is effected by the escape of minute biciliate protoplasmic bodies, the zoospores, which, on coming to rest, reproduce the parental form.

Imprisoned in the lichen thallus, the algae increase by division, but the production of zoospores is suppressed. **Trentipholia umbrinum** unites with many lichen fungi. This is a filamentous species of a brown colour, due to the presence of brown granules in the sheath. In the lichen thallus the filaments are often broken up, the individual cells then functioning. The plant is found free in nature about the base of beech trees in shady situations, where it forms colonies of a rusty brown colour. It is not common in the locality, but may be found in some quantity at Bonhard. The Nostoes are blue-green algae consisting of filaments of loosely-connected cells enclosed in a gelatinous sheath, forming nodules of varying size, which often become confluent. In one stage of their life-history the filaments, or chains of cells, are free, but under suitable conditions they multiply rapidly, and the gelatine secreted by the individual cells becomes the common sheath. The Nostoes are found on stones in streams, on wet rocks, amongst moss, and on damp, shady paths. **Nostoe commune** sometimes appears on damp gravel paths in gardens, the brownish gelatinous masses proving a perplexing problem to the owner.

The lichen fungus is the product of a germinating spore from which it arises as one or more tubular branching growths, the hyphæ. The growth is always apical; and as the hyphæ elongate cross walls, or septa, are formed behind the growing points, they thus become multicellular, and the whole fungus tissue is composed of modifications of these hyphal threads. Unlike the algæ, the lichen fungi cannot be recognised as occurring free in nature, and it is only by their fruits that they can be classed with the Discomycites or cup fungi, in which the fruit is an open cup or disc, and the Pyrenomycites, in which the spores are enclosed until maturity in flask-shaped receptacles, the perithecia. These, then, are the combining elements in the lichen, and, in order to have a clear understanding of this combination, and how it differs from the higher vegetation, I shall invite your attention for a moment to a transverse section of a beech leaf. This is bounded on its upper and lower surfaces by a band of cells, the epidermal cells. The internal soft tissue of the leaf is known as Parenchyma, or ground tissue, and is formed by cell division. Standing perpendicularly to the surface there is a band of narrow elongated cells, termed the palisade cells, below which the tissue is of a looser arrangement, with many air spaces. This is known as the spongy parenchyma. The minute bodies enclosed in the palisade cells are chloroplasts, which in the presence of sunlight are capable of decomposing carbon dioxide, and manufacturing all the substances necessary for the building up of the plant. All the cells in the leaf are in close contact, or, in other words, organically united.

Turning to the transverse section of a foliaceous lichen, **Xanthoria parietina,** we find in it a cortex tissue of thick-walled cells, corresponding in some aspects to the epidermis of the leaf, but differing from it entirely in other respects, as it is a pseudo-parenchyma, or folu tissue, formed by the close union of the hyphæ. Beneath the cortex is a stratum of green cells, Algæ, but when thus imprisoned in the thallus they are termed gonidia. Below the gonidia we have a broad zone of loosely interwoven hyphæ, with abundant air spaces, which becomes looser as it passes into the lower cortex. This is known as the medulla, or pith. Let me emphasise the fact that there is no organic union between the gonidia themselves, nor between these bodies and the surrounding hyphæ. It will, however, be obvious that there is a certain similarity of structure in the leaf and lichen, and, despite the fact that gonidia and fungus are foreign in other respects, yet the gonidia function in the lichen thallus as if they constituted an integral part of the plant, corresponding to the Chloroplasts in the beech leaf. Further, this leaf-like structure has been evolved to meet the same physiological necessity of exposing the chlorophyll bodies to the light in thin lamina. This stratified arrangement of gonidia and hyphæ in the lichen thallus is termed Heteromerous, and obtains in the great majority of these plants.

The gelatinous lichens, of which the Nostoes are frequently the Algal constituents, are simple in structure. In many species there is no proper cortex, and no stratification of gonidia and hyphæ, as we saw in our former illustration. The gonidial filaments are whole and distributed without order through the thallus, and the hyphæ ramify in the gelatinous sheath. Nevertheless, when permeated by the fungus, the Nostoe is modified into lobes, characteristic of the species to which it belongs. This unstratified arrangement of gonidia and hyphæ is termed Homoimerous. The Collemacea are a large family of these gelatinous lichens, dark green in colour, almost black when dry; growing on trees, rocks, and the mortar of old walls. Of all lichens, these seem to benefit most by a wet summer. Under these conditions **Collema flaccidum** Ach. may be found covering considerable areas of rock in Glen Farg; and in the same place **Leptozium lacerum** S. F. Gray is frequent, growing over mosses and sometimes attaining a great size. **Collema pulposum** Ach. is found on rocks near Almondbank, and **Collema granuliferum** Nyl. occurs on rocks at Hell's Hole, where also were found, within a foot of each other, the Nostoe pure and simple, and the Nostoe permeated by the fungus and transformed into the characteristic lichen thallus.

The discovery of the dual nature of the lichens, as now understood, is of comparatively recent date, and forms a very interesting chapter in the history of Lichenology. Previous to 1869 lichens were believed to be a class of plants intermediate between Algæ and Fungi; and as such are described in our old Floras. The gonidia were believed to be reproductive bodies, and to originate from the hyphæ. In 1866 De Bary had suggested that certain gelatinous lichens arose as the attack of an Ascomycetes fungus, and in 1869 Swenduer, a Swiss botanist, extended De Bary's suggestion to include all lichens.

"As the result of my researches," he said, "the lichens are not individual plants in the ordinary sense of the word; they are rather colonies of hundreds of thousands of individuals, amongst which one dominates the whole while the rest, in perpetual captivity, prepare the nutriment for the master, a fungus parasite which has caught hold of them and compelled them into its service. It surrounds them as a spider does its prey, but, while the spider sucks its prey, leaving it dead, the fungus excites the algæ to more rapid activity, indeed to more rapid increase." Subsequently, a series of synthetic cultures confirmed the conclusions of the Swiss botanists. The spores of lichens were germinated and brought into contact with suitable algæ, when it was found that the hyphæ clasped the algæ, grew around them, and finally a thallus was formed. The contact stimulated both algæ and fungus to more vigorous growth, and further, if the algæ were withheld, the fungus made no further progress, but died away. Objections, however, were raised to Swenduer's conclusions as to the fungus being entirely a parasite on the algæ. The long life of the lichen was pointed to as incompatible with any theory of pure parasitism, and it was shown that certain benefits must accrue to both partners in the association. The term simbioses, or conjoint life, was then adopted, as expressing this relationship.

The Ascomycetes class of fungi, to which these lichen fungi belong, are mainly soprophytes living in the humus of the soil, or on decayed wood and charcoal, from which they derive their nutriment. But in their alliance with algæ their mode of life has entirely altered. They are no longer dependent on an organic substratum, the algæ furnishing all they require of organic nutriment. The nutriment of the lichen is derived, in the first instance, from atmospheric precipitation, and the nutrient substances dissolved in it. This they absorb over all their surface, not only as water, but they are capable of condensing moisture from a saturated atmosphere. As a proof of this I may mention the fact that a large plant of **Lobaria pulmonaria,** collected 12 months ago, lying on the window-sill of my own house in an unheated room, becomes limp in rainy weather. Their sole dependence on moisture seems to be perfectly clear in the foliaceous and fruticose lichens. The foliaceous are often furnished with root-like attachments, by which they are held to their substratum, but which are not organs of nutrition. In **Parmelia syphodes,** a common plant everywhere, these attachments are awanting, and the plant is only adpressed to the substratum. There is no conduction in the fruticose lichens, as has been proved by immersing the base of the plant in water, when the upper part remained dry, but where water was poured over the plant it was absorbed at once. This statement also receives support from the fact that in some of the Cladoniacea (**C. sylvatica**) the plant is often found blackened and dead at the base, while fresh and vigorous at the apex.

The crustaceous lichens disentegrate and dissolve the rocks and stones on which they grow. Certain elements in solution derived from this source are believed to be absorbed by the hyphæ, and serve to nourish the plant. But the indifference of some of these crustaceous plants to the nature of their substratum arouses doubts as to whether this is really a source of nutriment necessary to their growth, and whether the undoubted partiality of many lichens for certain rock formations may not arise from other causes rather than from the nutriment derived from them.

There is much in the physiological relations of gonidia and fungus in the lichen thallus not well understood. It can hardly be doubted that the gonidia function as organs of assimilation, and that the products of assimilation become food for the fungus. The difficulty arises when it is asked what the fungus contributes to the gonidia. The requirements of the Algæ in a free state are simply water, and a certain amount of light and air. The cell walls of the hyphæ are composed of various carbohydrates akin to cellulose, known as Lichinin, or lichen starch, which readily absorbs water, and upon which the algæ can draw for moisture. It is presumed that in the excretions of the hyphæ the gonidia find those necessary elements which in a free state they would absorb from their environment, but of which they may be deprived when imprisoned in the lichen thallus.

The byproducts of this simbiotic union are remarkable. Calcium Oxalate, or oxalate of lime, is of common occurrence in the crustaceous lichens, in the form of crystals. These sometimes occur in such abundance as to form a high percentage of the whole plant. Of more importance are the lichen acids, occurring as very minute granules on the exterior of the hyphæ, from which chemists have succeeded in isolating many acids peculiar to lichens. These granules are insoluble in water, but, when treated with alkalies form the basis of the lichen dyes. In the lichen thallus they are usually colourless, but when developed the colour is bright, as in the common **Xanthoria parietina,** which is of a bright orange colour. This only occurs when the plant is exposed to the sun's rays. Growing in shade, the plant is pale green, hardly to be identified with the brilliant normal form. These lichen acids have not been found in the gelatinous lichens. I have already remarked on the importance of moisture in the economy of the lichens, and of this, and its effects on their distribution, our own county affords an excellent example. The western division of the county, especially on and around Ben Lawers, is noted for the wealth of its Lichen Flora. In the years

1923-4 rain fell at Killin on 502 days, and at Perth, during the same period, on 305 days. Further, these mountainous regions are frequently wreathed in cloud and mist, forming admirable conditions for the growth of lichens. Thus we find whole families, genra, and many species, less or more common in Western Perthshire, which are barely represented, or altogether awanting, in the Eastern portion of the county. Further, it is significant that several species hitherto only associated with Ben Lawers, in Perthshire, have recently been found occurring on wet rocks near Perth. A considerable number of lichens are capable of living for long periods submerged in streams, or on rocks over which water trickles during half the year, and intermittently with heavy rains, during the other half. These are fairly well represented near Perth, and mostly belong to the Pyrenomycetes division of the lichens, and, with one notable exception, are crustaceous plants. This exception, **Dermatocarpon acquaticum** A. Zahlbr, is a fairly large foliaceous plant, with thick leathery thallus, which occurs at the Linn of Campsie, on the basalt dyke and boulders of the same rock in the bed of the Tay. The plant can only be collected when the river is at summer level, and it can easily be demonstrated that, with the advent of a wet summer, these plants must be submerged for a period of two years. The lichen seems to be always associated with the moss **Cinclodotus fontinalus,** but the association is probably merely a mechanical one, the spores of the lichen being washed into the base of the moss plant, and there germinating.

The lichens, depending so much on moisture, very quickly lose it in a dry atmosphere. Indeed, their lives alternate between periods of activity and passivity. In these circumstances the foliose and fruticose plants become dry and brittle, and all vital functions cease. Kerner, in "The Natural History of Plants," describes the lichens of the Tundra after rain as forming a soft, tumid carpet under foot, but, after a few hours of sunshine, becoming so dry and brittle that every step was accompanied by a crunching noise. Under these circumstances the crustaceous plants become cracked into minute areola, by which moisture is quickly absorbed, when they close up again. Many lichens thrive best when not directly exposed to the rays of the sun. In fact, some species can only be found in shady situations. The proximity of trees has a great attraction, and some of our dry stone dykes bordering a wood, or lined by a row of trees, are very prolific. In these circumstances a number of lichens, which are typically corticolous or bark lichens, flourish on the dykes, and not on the trees which shade them. The Peltigeracea are shade lichens, affecting open woods, shady banks, and rocks. In these situations transpiration is slower, and vitality is retained longer under dry conditions. The colour of lichens varies a good deal with the amount of moisture present in the thallus. When dry, some species become dark, others light and faded-looking, but with a return of moisture the cortex becomes more transparent, and the green cells of the gonidia shine through, giving the plant a bright or fresh green appearance.

Lichens do not thrive where the air is impure, and near our manufacturing towns, when present, are poorly developed. Whether they are affected by the impurity of the air, or by deleterious substances dissolved in atmospheric precipitation falling on them, is not known. In any case, if the presence of lichens is a guarantee of the purity of the air, I am pleased to assure you we do not suffer in this way, as these plants are plentiful around Perth.

Lichens grow rapidly when young, but growth becomes extremely slow as they approach maturity. Extraordinary calculations have been made as to the longevity of the lichens. Dr. Lauder Lindsay, in "Popular British Lichens," says that some species growing on the primitive rocks of the highest mountains of the world are estimated to have attained a thousand years, and another author mentions seeing the same specimen of **Sticta pulmonaria** on the same spot on the same tree after fifty years. I can offer no data, but from my own observations I should be loth to accept those calculations. Amongst so large and diversified a class as the lichens, I believe there will be great differences in longevity. When one surveys some of our dry stone dykes, with the coping stones encrusted with **Parmelia saxatilis,** it has the promise of enduring as long as the wall itself. On the other hand, **Pelligera polydactyla,** which is common in the neighbourhood, one can only regard as a biennial, growing rapidly the first year, fruiting the second, and, by the spring of the following year, the thallus is dead, the only vitality left being in the spores.

Xanthoria parietina covers the eastern wall of Murray's Royal Asylum with hundreds of its bright orange growths, many of which may be found at all times in a state of disintegration, a bulge appearing in the centre, or oldest part. This no longer rests on the substratum, but crumbles down and disappears. The decay spreads outwards, while the plant remains quite vigorous at the margin, but this is the beginning of the end; there is no rejuvenation. Meanwhile a young plant may appear within the circle, and, extending outwards, follows in the wake of its predecessor. Incidentally, it may be mentioned that the muslin moth, **Nudaria mundana,** is found here, the larvæ feeding on the lichen.

The fruits, or reproductive bodies, of the lichen belong entirely to the fungus, the algæ taking no part in this important function. These bodies arise on the surface of the thallus, or at the tips of the lobes, as small cups or disc-like growths, termed Apothecia, or, in close flask-shaped receptacles, Penthecia. There are two well marked types of the Apothecia. In the first the thallus grows up around this body, enclosing it, as it were, in a cup. In the other the hyphæ alone forms the outer tissue. The Apothecia may be soft, and brightly coloured, red, yellow, or brown, or they may be black, and horny in texture. The contents of the Apothecia are asci and paraphyses, cellular bodies standing vertically to the surface of the Apothecia, and form the hymenium. The paraphyses, which are always formed in advance of the asci, are slender and thread-like, usually thickened and coloured at the apex. These form the larger part of the hymenium, and are closely packed, and cohese laterally by means of a gelatinous substance. Rising to a uniform height, they overtop the asci, and thus form the surface of the Apothecia, and from them the latter derives its characteristic colouring. The asci are much stouter than the paraphyses, widening upwards from a narrow base. They vary a good deal in size and shape, being cylindrical, clavate, or obovate. These are the mother cells of the spores, in which the latter are produced by free cell formation, and in which they are retained until maturity. As the asci develop they thrust themselves upwards between the paraphyses, but there is no uniformity in this, and asci and spores may be met with in all stages of development. The number of spores contained in an ascus is typically eight, but in some species the number is reduced to four, two, or even one. They are usually at first hyaline, but many become brown with maturity. Many consist of but a simple cell, or they may be intersected by cross walls, or septa, and thus become two celled, three celled, or many celled. The contents of the Perethecia do not differ from the Apothecia, but in quite a number of these Pyrenomycetes the paraphyses disappear at quite an early stage in the development of the spores. The spores of lichens are very minute, and easily moved by air currents, and, should they alight on a suitable substratum, will germinate, but, as we have already seen, the suitable algæ must be present. Should this be found, a thallus will eventually be produced.

There are two small genera of lichens in which this important matter is not left to chance. These are mostly rather rare lichens, and are only represented in our locality by one species **Staurothele umbrina** A.L.Sm., a crustaceous plant occurring on wet rocks in the Muirhall Quarry. In these plants, minute gonidia, the green cells are enclosed in the perithecia, forming lines between the asci, and these are discharged with the spores, contact being thus assured. Many lichens, however, are not the product of free algæ and germinating fungus spore cells, in the manner which I have tried to describe to you. In many of our common lichens, Apothecia are rarely produced, and the lichen is propagated by vegetative bodies termed Soredia. These soredia consist of one or more gonidia enclosed in a weft of hyphæ, and these bodies burst through the cortex of the lichen in immense numbers. This rupturing of the parent cortex is not accomplished in an irregular manner. It is constant for the species occurring at the tips of the lobes, or in lines, furrows, or minute punctures. The soredia are light and easily blown about by the wind, and, should they alight on a suitable substratum, growth may begin at once, both constituents being present. It will be recognised that this vegetative method of propagation has many advantages over that of propagation by spores, with all its attendant hazards. What causes have contributed to bring about this suppression of the purely fungus fruit are not understood, but it is well known that in those lichens in which soredia are freely produced the Apothecia are rare, or entirely awanting.

In connection with this subject I should like to relate to you an incident which lately came under my notice. As the result of the clearing up of the debris after the wood-cutting on Kinnoull Hill, there were left many burned patches of ground, and in the summer of 1924 these burned areas on the northern shoulder of the hill were found to be occupied by a small lichen in immense numbers, sometimes forming a sward. The plant was a small foliaceous one, blue-green in colour, with lobes about three centimetres in length. The summer was abnormally wet, and for long periods the lichen could hardly ever have been dry. No fruit was borne, but on every lobe there appeared a neat circular incision of the upper cortex, from which was extended a mass of blue-green soredia. By the following summer the plant had entirely disappeared, but again, in the summer of 1926, another lichen appeared on the same ground, much less numerous, but very like its predecessor in every way. The second plant produced no soredia, but fruited freely, and there was no difficulty in identifying it as **Pelligera spuria** DC., a lichen not seen in the locality before, and probably rare in Perthshire. Now, one is left with the questions—Was the second plant born from the abundant soredia of its predecessor, and was this soredia condition induced by the abnormally wet conditions under which the plant grew, or were the two plants specifically distinct?

Accumulations of soredia may be met with frequently about hedge bottoms, trees, walls, and rocks, invariably in shady situations, where the soredia increase by division, but no thallus is formed, and this condition is termed Leprose. Dr. Lindsay, in "Popular British Lichens," writes:—" The leprose condition is the simplest form under which Lichenose vegetation exists. It is the rudimentary condition of many species, and the abnormal or abortive form of others, depending on, or produced by, an absence of the external conditions necessary or favourable to development." On this subject one might speculate on the possibility of soredia from many different lichens being intermingled in these accumulations and mutually antagonistic to the further development of any particular species. Lichens are of great economic importance to the northern peoples, Laplanders, Icelanders, and, in a lesser degree, to Norwegians and Swedes. In Lapland, the reindeer moss forms the principal winter food of the reindeer, which Dr. MacMillan describes as the life, hope, and wealth of the Laplander. It carries his burdens with the patience of the ass, yields its milk like the cow, and transports him over the frozen, snowy wastes with the speed of the horse. Its flesh serves him with food, and its thick, furry skin provides comfortable garments and bedding to protect him from the rigours of the Arctic night. In Norway, also, he says, he found that in many parts the reindeer moss was used as winter food for cattle. The plant is scraped with iron rakes into heaps, which are transported down to the farms on sledges with the first snowfall. Iceland moss, **Cetraria islandica,** is used as an article of food by Laplanders and Icelanders. The plant occurs on mountains in Britain, but never attains to the luxuriance of the northern plants. In its preparation it is first ground to powder, and then soaked in a weak alkaline solution to remove the bitter principal characteristic of the plant, after which it is made into bread, alone, or mixed with meal. With the improved condition of the people of Iceland in recent years, the consumpt of the lichen as food has greatly declined. Iceland moss attained some popularity in this country as a food for invalids. Boiled with milk, it formed a jelly, which was believed to be beneficial in certain diseases, but now it seems to be scarcely known, even to the medical profession.

Tripe de roche, or rock tripe, of the Canadian voyageurs, is another lichen which is sometimes eaten by these men, and has also proved of great service to Arctic explorers when in straits for food. The following extract from " The Narrative of a Journey to the Polar Sea," by Capt. John Franklin, is not without interest. He writes:—" The next two days the surface of the country was covered with large stones, bearing a lichen which the Canadians call Tripe de roch, or rock tripe, a substance to which the present travellers owe their safety and existence, as without it we must have died of starvation. By botanists the plant is called **Gyrophora,** from its circular form, and from the surface of the leaf being marked with curved lines. Dr. Richardson has described and engraved four species. We used all four as an article of food, but, not having the means of extracting the bitter principal from them, they proved nauseous to all, producing severe bowel complaints."

The Gyrophoracea are dark green leathery lichens, a number of which are not uncommon in Western Perthshire, but of rare occurrence in the South-east. Locally they are only represented by a few plants of **Gyrophora polyphylla** Hook, growing on a glacial boulder on the hills behind the Lynedoch Monument.

In the so-called manna lichen, **Lecanora esculenta,** some people have sought a rational explanation of the miraculous provision of manna to the Israelites. The plant is found in the arid regions of North Africa, and in Asia, growing on the ground, and on rocks, from which it is liable to be torn by high winds, and carried long distances, sometimes falling in such abundance as to cover the ground to a depth of several inches. By the natives of these regions where it occurs it is used as an article of food, being mixed with meal, and baked into bread. It is also said to be eaten by animals, and there are instances on record where this shower of the lichen has fallen when the people were in dire straits through famine, when it was received as bread from heaven. The plant is described as consisting of small irregular lumps of a greenish white colour, inodorous and insipid, and containing in its composition 60 per cent. of Calcium Oxalate crystals.

The dyeing properties of lichens have been long and widely known, and in the North of Scotland dyeing with lichens has long been practised as a home industry. Dyes can be derived from many lichens, but the dyes of most industrial importance are Cudbear and Orchil. The first named is derived from **Lecanora tartarea,** a crustaceous plant common on rocks and stones in the North and West of Scotland, but still more abundant in Norway and Sweden, these countries supplying the lichen from which the dye is manufactured. Orchil is derived from **Roccella tinctoria,** a shrubby lichen found on rocks near the sea in many warm countries. Both dyes were long used extensively in the dyeing trade in Perth, but of late the chemist has been very much in evidence in the dyeing industry, and I understand Cudbear is no longer used.

During the Middle Ages, and even in later times, lichens figured largely in medicine, when it was believed that in Nature, and especially in the vegetable world, there was provided a cure for all the disease which affect humanity. Perhaps Shakespeare expresses this belief in "Romeo and Juliet" when Friar Lawrence soliloquises thus:

"O micle is the powerful grace that lies
In herbs, plants, stones and their true qualities,
For nought so vile on earth do live
But to the earth some special good doth give."

Further, these remedies were to be sought in a certain supposed likeness to the parts of the body affected, or to the symptoms of the disease; and to this practice we owe the common names of some lichens. Thus the lungwort lichen, **Laboria pulmonaria,** a large foliaceous plant with a strongly reticulated thallus, was supposed, from its resemblance to the lungs, to be a suitable cure for diseases of these organs. The orange lichens suggested a cure for jaundice, and the spotted thallus of **Peltidia apthosa** was used as a cure for thrush in children, but the most extraordinary of these remedies was the use of the dog lichen as a cure for hydrophobia. This was the prescription of a certain Dr. Mead, who had found it efficacious as a cure for the bite of a mad dog. Apart from the nearly obsolete Iceland moss, no lichen is now used in medicine. It may also be stated that no lichen is known to be poisonous.

In conclusion, I should like to say a word on the collection and identification of the lichens. These may be collected at all times, but in spring they are at their best. At that season growth is most vigorous, and many of them will be found in fruit. For those growing on trees, all that is required in their collection is a stout knife, but for those growing on rocks, the crustaceous plants, a hammer and chisel are necessary. As they cannot be separated from the substratum, this must also be secured. As the classification of the lichens is largely based on the nature of the fruit and spore characters, the microscope is essential in the examination and identification of the species. When once the classification has been grasped, the identification of a number presents no great difficulties; but, on the other hand, there are a number on which no fruit is found, and also a great number in which morphological and spore characters differ so slightly that their identification is attended by great difficulty. In the two volumes of "The Monograph of British Lichens," by Miss A. Lorrian Smith, full descriptions of all British lichens will be found, with spore measurements, and many helpful illustrations of the various families and genera. These, with a "Handbook of British Lichens," by the same authoress, will be found in the library of the Society.

My thanks are due to Mr. Ritchie for the many lantern slides he has so kindly supplied me with, and to Mr. Coates for exercising on some of these his well-known abilities in colouring. The two fine slides of lichens *in situ* have a melancholy interest, as they are from photographs taken for me by our late member and friend, Mr. James Stewart.

XVIII.—*The Geology and Scenery of Cornwall.*

By Henry Coates, F.S.A.Scot.

(Read December 10, 1926.)

It is true of all regions of the country that the present features are largely the outcome of the geological structure of the underlying rocks, but it is specially true in regard to Cornwall. The reasons for this are twofold—first, because the geological features of the Cornish peninsula are very strongly marked, and, second, because they are nowhere masked by a thick covering of soil and vegetation.

I.—GEOLOGICAL STRUCTURE.

Glancing at a geological map of the British Isles, we find that the rocks of Cornwall, in common with those of the rest of the country, become older as we traverse the county from east to west. With the exception of one or two insignificant patches of Pliocene deposits, to be noticed later, the rocks all belong to the oldest of the three great divisions of geological time—the Palæozoic, or Primary. For this reason, the scenery, like that of the North-West Highlands of Scotland, where rocks of similar age and texture are found, presents a bold and rugged character, in marked contrast with that of the rest of England, where, for the most part, newer and softer rocks are found.

The rocks of which the earth's crust is composed are of either sedimentary or igneous origin. We will examine each of these in turn.

(A) THE SEDIMENTARY DEPOSITS.

The great mass of Cornwall consists of hard, dark, gnarled slates and shales, known locally under the general name of "killas," through which protrude a series of bosses, or masses, of granite. These beds of killas, and the associated granite masses, form the solid framework of the peninsula, in which the subsidiary formations are set.

The killas is of varying age, texture, and mineralogical composition. The series in the upper or north-eastern portion of the county, except those of the extreme north corner, are of undoubted Devonian age, as evidenced by the fossil remains of fishes of that period which are found in them.

Around Veryan Bay, and also in the northern portion of the Lizard promontory, are two small zones of Ordovician or Lower Silurian age.

Intermediate between these Devonian and Silurian deposits there occur, towards the south-western end of the peninsula, extensive series of killas which are practically barren of fossils, and which at the same time are so altered and distorted that it is difficult to determine whether they should be relegated to the one period or the other. Among these doubtful deposits are the Mylor Series and the Falmouth Series.

Travelling still farther south, we come to a series of formations in the Lizard peninsula representing the oldest period of the geological record, the Archæan, or Pre-Cambrian. This very interesting and striking series consists of highly metamorphic or altered rocks, including a zone of Hornblende Schist, immediately to the south of the Silurian zone already referred to; a large mass of the beautiful green and crimson serpentines for which the district is famous; and extensive intrusions of Gabbro, an eruptive igneous rock.

Returning now to the northern extremity of the county, we come to another series of sedimentary rocks, younger than the Devonian series, which we have taken slightly out of their proper sequence, in order to dispose of the more widely distributed formations first. These younger rocks, which extend also into the adjacent county of Devon, consist of black shales and slates, greywacke, and thin seams of chert and impure coal. They belong to the Culm-Measures, the lowest member of the Carboniferous Series, which lie immediately above the Devonian and Old Red Sandstone deposits.

Passing over the whole of the Mesozoic or Secondary deposits, and all the older Cainozoic or Tertiary deposits, which are entirely unrepresented in Cornwall, we come now to the one or two insignificant patches, already referred to, of Pliocene deposits, representing the youngest of the Tertiary formations. These beds occur near St. Erth, in the neighbourhood of St. Ives Bay, and yield abundant fossil remains of the shells characteristic of the Pliocene period.

Post-Tertiary deposits are represented by extensive beds of blown sand, by raised beaches and the remains of buried forest beds, and by beds of boulder gravels, all of which occur at various points around both the north and south coasts.

Although there is no evidence of the actual ice cap having extended as far south as Cornwall during the Glacial Period, yet the Post-Tertiary deposits just referred to—other than the blown sand—show that while Scotland and Northern England were buried under one vast sheet of ice, the South of England was subject to all the rigours of an Arctic climate, interspersed

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with warmer intervals, and that the land surface was alternately elevated and depressed, just as in the northern portions of the kingdom.

It is evident also that, as the ice sheet and the glaciers gradually melted, the land to the south of the ice-foot must have been flooded with torrential waters, liberated from the melting ice, and charged with detritus borne down from the higher lands. From the alternations of climate and of land-surface arose the buried forest beds and the raised beaches that we see around the coast of Cornwall to-day; and from the ice-flooding arose the deposits of boulder gravels, etc., analogous to the boulder clay, kames, and moraines of the North.

(B) THE IGNEOUS ROCKS.

Leaving the orderly succession of sedimentary deposits of successive periods—Archæan, Silurian, Devonian, Carboniferous, Pliocene, and Post-Tertiary—we come now to another class of rocks, differeing from these entirely both in their origin and in their structure. These are the various igneous rocks, which were originally in a molten condition owing to the internal heat of the earth's crust, and which have crystallised from that state as they cooled, at a greater or less depth beneath the surface. In one respect they resemble the sedimentary rocks, in so far as both have been liable to subsequent alteration by the forces of internal heat and pressure.

Igneous rocks, which occur in association with sedimentary rocks, are of two kinds—those which have been formed contemporaneously with the strata in which they occur, and those which have been intruded into the strata subsequent to the formation of the latter. Both of these important classes are represented in Cornwall.

The contemporaneous or interbedded igneous rocks consist of beds of ancient lavas and volcanic ash, which have been ejected from volcanoes long since extinct. Such beds are found in many parts of Cornwall, such as the narrow bands of greenstone and tuff which occur around Penzance and Marazion, St. Erth, Padstow, Tintagel, Callington, etc.

The intrusive igneous rocks, however, are much more extensively developed in the county. To this class belong the great bosses of granite already referred to, which have such a marked influence on the topography and scenery of Cornwall, as well as on its agricultural and industrial life.

Four of these bosses of granite occur in the length of the peninsula, like beads strung out loosely on a necklace. Going from north-east to south-west, the first we come to is the one which forms the foundation of Bodmin Moor. It consists, like the others, of an irregular oval, some thirteen or fourteen miles in length, and rising to a height of 1368 feet in Brown Willy, the highest hill in Cornwall. It covers in all an area of about sixty-five square miles.

Travelling down the peninsula, we come next to the St. Austell mass, rising to 1034 feet in Henbarrow Hill. This boss covers only about half the area of the previous one, but it is important as the source of most of the china clay and china rock which are among the leading exports of the county.

Next we come to a nearly circular area, some fifty-five miles in extent, lying to the west of Penryn, and rising to 822 feet in Carn Menetez. This boss has long been famous for its granite quarries, whence have come the building material of many important public buildings in London and elsewhere.

Lastly, we come to the Land's End promontory, which is almost wholly made up of one great mass of granite, equalling in area that of Bodmin Moor. The granite of this area is characterised by the great size and prominence of its porphyritic crystals of felspar. It is this character, together with the bold rectangular jointing of the rock, which imparts its rugged boldness to the coast scenery of the Land's End.

In addition to these four principal bosses of granite, covering altogether an area of some 220 square miles, there are three or four smaller masses, such as those at Camborne and Redruth, which are no doubt outliers of the larger adjacent masses.

These eruptive masses of crystalline igneous rock may be regarded as but the outward manifestations of a vastly greater development of similar material hidden beneath the surrounding crust of sedimentary strata.

That the granites are of more recent production than the sedimentary deposits through which they have been protruded is evident from the fact that the latter have been intensely altered where they have come in contact with the molten granites. Sometimes the metamorphism extends for a distance of nearly half a mile from the planes of contact, forming an "aureole" of altered strata round each intrusion of granite.

Among other forms of intrusive igneous rock found in the county are the "Elvans," or dykes of quartz-porphyry, which run out from the granite masses into the surrounding sedimentary rocks. The richest lodes from which tin and other metallic ores are got are generally found in association with the elvans around the margins of the granite intrusions, as at Camborne, Redruth, St. Just, etc.

The serpentine rock of the Lizard promontory has originally been an intrusive igneous rock, but the olivine which it contained has been decomposed into a hydrated silicate of magnesia and iron, giving rise to its peculiar colour and texture.

Yet another intrusive igneous rock is the gabbro, an altered form of basalt, which also is found on the coast of the Lizard, where it seems to penetrate the serpentine, showing that the latter must have been an older intrusion.

It would serve no useful purpose to dwell here on the economic products of the rocks of Cornwall, except to remark that some of them have had a striking effect on the topography and scenery of the county. Thus, the working of the china-clay, or kaolin, in the neighbourhood of St. Austell for centuries has resulted in the accumulation of miniature mountains of white debris, many scores of feet in height. These accumulations, forming what have been jocularly called the "Cornish Alps," are visible from a distance of many miles. So also the working of stream-tin has given rise to extensive clay-flats in the estuaries of the rivers where the tin-mining industry has been carried on for even a longer period than the china-clay industry. In such ways does man, in his endeavours to win wealth from the bowels of the earth, transform the face of nature.

2.—TOPOGRAPHY.

Having made the rocks yield up some of the hidden secrets of the earth's crust, we are now perhaps in a better position to unravel the problems presented by the outer surface of that crust.

If we examine an orographical map of Cornwall, we shall see that the outstanding topographical feature of the peninsula of which it consists—some seventy-five miles in length—is the ridge of comparatively high ground which forms its central crest, and which rises into four elevated areas, corresponding to the four bosses of granite which, as we have seen, pierce the sedimentary rocks. These areas, we shall find, are as a rule bare stretches of moorland, covered with gorse and heather, with no great depth of soil, few trees, and little cultivated land.

The general contour of the land, apart from the granite areas, presents a gnarled and contorted appearance, corresponding roughly with the distorted structure of the shales and slates which make up the killas. It is this same structure which leads to the extraordinarily complex systems of some of the river estuaries, or fjords, as they may properly be called. Conspicuous examples of these are the estuaries of the Tamar, the Fal, and the Camel, as well as the so-called Helford River.

The bold and rugged character of the cliff scenery in many parts of the coast speaks eloquently of the hard, crystalline, and contorted rocks which make up the coast-line in places where it is not indented by creeks and estuaries. Such, for example, are the coarse granite of the Land's End, the serpentine, gabbro, and schist of the Lizard, the killas of Godrevy Point and

St. Agnes Head, and the black slates and shales of Tintagel—all places familiar to the tourist from the picturesque and striking nature of the cliffs which fringe the shore at these points.

The hardness of the rocks, again, and their unyielding character, account for the absence of any considerable deposits of rich or deep soil, and the consequent limited area of arable land. From the upper moorland tracts, however, long coombes or valleys descend towards the coast on both sides of the peninsula, and these are frequently well wooded and luxuriant in their vegetation, forming a marked contrast to the appearance of the bare uplands. In some of these sheltered valleys, indeed, on the south coast, a sub-tropical flora has been cultivated, thanks to the humidity and mildness of the climate.

The more important rivers and streams, with their tributaries, all take their rise on the high granite plateau of Bodmin Moor. This applies to the Attery, the Kensey, and the Inney, all tributaries of the Tamar; the Lynher, the Seaton, the Looe, and the Fowey, all of which flow into the English Channel; as well as the Camel, and its tributary the Delank, which flow northwards into the Atlantic.

Of the remaining streams and rivers, the Fal, the Tresillian River, and the Gannel take their rise in the area of the St. Austell granites; the Penryn stream, the northern feeders of the Helford River, the Cober and the Hayle River in the region of the Penryn granites; and the Marazion, Trevaylor, Newlyn, and Lamorna streams among the Land's End granites.

The traveller to Cornwall by the Great Western Railway must have been struck by the great depth of the valleys which have had to be spanned by towering viaducts. This is due to the hard and impervious texture of the rocks—altered shales and slates, granite, serpentine, etc.—out of which the Cornish plateau has been carved by the atmospheric agencies, by the rivers, and by the sea.

Another way in which the geological forces have been at work in modifying the surface features of the land is in the gradual silting-up of many of the rivers and creeks by the deposition of detrital material—sand, gravel, mud, and clay—brought down from the upper reaches of the streams. This has been particularly noticeable in the case of the Fal and its tributaries, where careful observations have been made over a long period of years, and where early maps are available for comparison with those of recent date. From these observations it appears that an enormous amount of deposition has taken place in the lower reaches of the river and its creeks, and that the tidal reaches have correspondingly receded seawards. It is said, for instance, that in Roman times the estuary extended as far up as Tregoney, where there was an important settlement, accessible to shipping. Now the river at this point is a comparatively narrow stream, flowing peacefully between green meadows.

Opposite Malpas, on the Truro River, a tributary of the Fal, the creek has silted-up to a depth of six feet since 1681. At some points farther down the estuary even greater changes have taken place. In the channel opposite Penpoll the water is now ten feet shallower than it was in 1698, when an Admiralty survey was made. Farther down the same creek, at Restronguet Pool, where there were 42 feet of water at low tide in 1698, the bank was uncovered, under the same tidal conditions, in 1855, showing that within a span of a hundred and fifty years over forty feet of material had accumulated. While these changes have undoubtedly been accelerated by man's intervention in the stream-tin workings, yet they are mainly the result of the slow processes of Nature's laws.

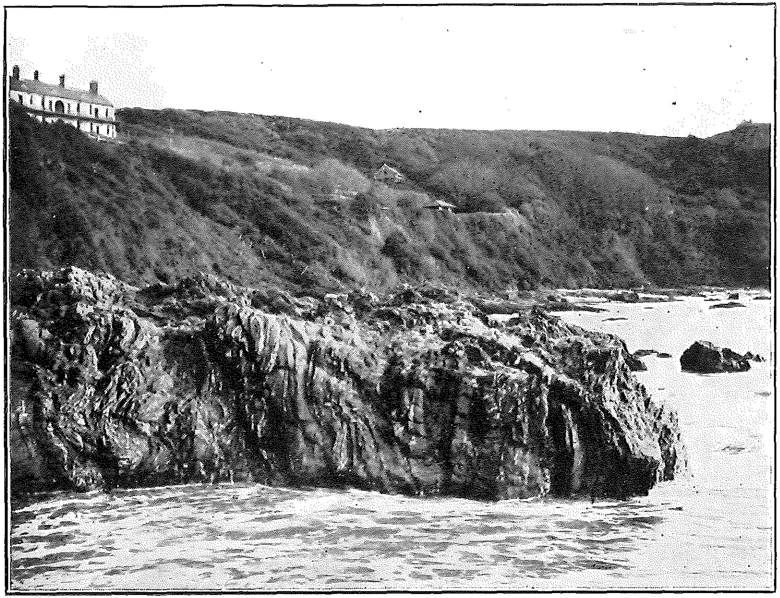
It will be observed that the river deposits of which we have been speaking nearly all consist of fine materials—silt, mud, and clay. Coarse sand and gravel, such as are found on the valley floors and river beds of the Scottish Highlands, are rarely or never met with. The reason for this is that the Cornish streams, having a comparatively low mean gradient, flow much less swiftly, and their carrying capacity is correspondingly reduced. While a Highland stream of very moderate proportions is able to transport coarse shingle and even boulders of considerable size, the transporting capacity of a Cornish stream, at least in its lower reaches, is confined to finer and lighter material.

XIX.—*James Stewart.* (*1858-1926.*)

(Read 11th March, 1927.)

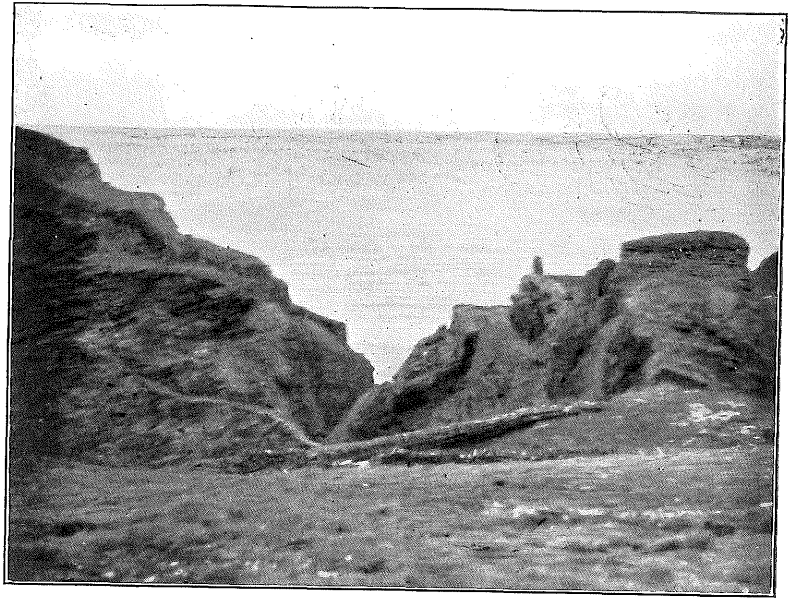
James Stewart was born in Perth on the 17th November, 1858. His father, John Stewart, was a well-known citizen of Perth, a dentist by profession, and one of the original members of the Perthshire Society of Natural Science and its first treasurer. James was educated at the old Trades' School, from which he passed to the Perth Academy, and, finally, to Edinburgh University, where he studied for his father's profession, and was a distinguished student. On the completion of his education, he entered into partnership with his father, and, on the death of the latter, became sole partner.

A man of strict integrity and noted for his professional skill, Mr. Stewart built up a very successful business, from which he retired in 1924, with, humanly speaking, the expec-



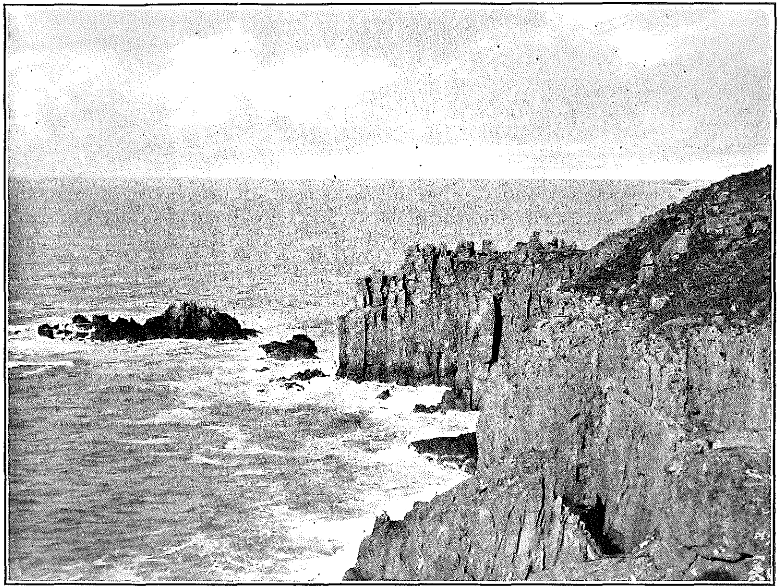
[*Photo, H. Coates.*

Contorted Killas Rocks at Falmouth.



[Photo, H. Coates.

Black Shales at Tintagel.



[*Photo, H. Coates.*

Coarse Granite Rocks at Land's End.

[Photo, H. Coates.

Serpentine Rocks at The Lizard.

[Photo, H. Coates.

A Bodmin Moor Stream.

[Photo, H. Coates.

On the Delank River, Bodmin Moor.

[*Photo, H. Coates.*
Greyston Bridge, over the Tamar. Built 1439.

[*Photo, H. Coates.*
New Bridge, over the Tamar, at Gunnislake. Built about 1500.

tation of having before him a good few years in which to enjoy his well-earned leisure, and his sudden demise came as a painful shock to his many friends and acquaintances.

Mr. Stewart became a member of the Society in 1882, and was thus connected with it for the long period of 44 years. During all these years he was an active member and a regular attender of the meetings of the Society, being frequently present at the excursions. In guiding the affairs of the Society, also, he took a prominent part, frequently serving on the Council, and was Vice-President for no less than six periods. During the early years of the Society there was an active Microscopical Section, and Mr. Stewart was appointed Convener of the Physiological and Pathological Section. This was the year following his election to the membership.

Mr. Stewart was characterised by a strong independence of mind, and, although interested in all branches of the Society's work in a general way, his own mental bias was towards Zoology and Comparative Anatomy. Nearly all his communications to the Transactions of the Society were on these subjects.

Of a cheerful, obliging disposition, he freely gave his professional services to several of our philanthropic institutions. Mr. Stewart's death leaves a blank in the membership of our Society, with which he was so long and honourably connected.

XX.—*On the Extermination of Rare Plants.*

By James Menzies.

(Read 11th March, 1927.)

Some months ago my attention was drawn to an article in the newspapers dealing with the extermination of rare plants. The writer betrayed little knowledge of the subject, and the article was hardly worth a moment's consideration, but, like the scorpion, there was a sting in the tail which deserves some notice, as, amongst the agencies concerned in the extermination of rare plants, he finally included the Botanist. The writer gave no reason for this assertion, and one can only infer that he alluded to the practice, not uncommon amongst botanists, of forming herbaria of dried plants, which can always be referred to, and which, in many instances, are regarded as pleasing mementoes of enjoyable days spent with kindred spirits in a common pursuit.

Rare plants are often confounded in the popular mind with plants remarkable for their beauty or fragrance, but, in many instances, they have neither, and, except to those with some botanical knowledge, would hardly excite the smallest interest. These plants are thus in a certain sense the peculiar possession of the botanist, and might easily be exterminated, and he alone would be aware of this. There must be few botanists worthy of the name who would exterminate a rare plant for the sake of possessing a dried specimen. To the local botanist the rare plants of his locality are always objects of his solicitude, and, so far as circumstances will permit, of his protection. The permanence of the conditions under which plants have become established are of the first importance in their preservation. Unfortunately these undisturbed conditions cannot always be assured near our populous towns, and even in more remote country districts rare plants are liable to extermination from causes incidental to the industrial and economic life of the population, and which have no relation to the plants themselves. They are also liable to extermination from purely natural causes, as the drying up of our smaller lochs and marshes, consequent on the accumulation of dead vegetable matter, and also from changes induced by abnormal weather conditions.

Many plants are found growing in the shade of trees, often finding their sustenance in the humus formed of the decaying leaves, and which quickly disappear with the removal of the trees. Within recent years, and especially owing to the exigencies of the war, there has been a vast destruction of our woodlands. The surroundings of Perth have suffered severely from this cause, and quite a number of our shade plants have thus been exterminated in the locality, such as **Goodyear ripens** Br. at the Muirward of Lethendy and at Kinfauns; the lesser twoblade, **Listera Cordata,** at the same localities; the chick-weed winter green, **Trientales Europeas** L., also at Kinfauns; the birds-nest orchid, **Neottia nidus anu** Rich. and **Pyrola minor** L., at Kinnoull Hill. It may also be mentioned that, of all the splendid fungus Flora that flourished on the humus under the trees on Kinnoull Hill, not one species can now be found.

Woody Island also has suffered from this cause. The timber-cutting has mainly been on the east side of the island, but this has had the effect of admitting more light, and thus encouraging the coarser herbaceous plants and grasses, in competition with which the finer plants suffer, and it is certain that a number of those plants mentioned in the late Mr. Barclay's carefully-compiled "List of Plants of Woody Island" could not now be found there. **Paris quadrifolia,** which has found sanctuary there for so many years, has declined of late, and during the past season I failed entirely to locate the plant.

What has been mentioned as occurring in our own locality must be characteristic of many other parts of Scotland, and it is no exaggeration to state that nearly a century may elapse ere the return of these plants now exterminated, even under the most favourable conditions of replanting. Of minor incidents causing the extermination of rare plants may be mentioned the plastering of an old wall on which **Saxafraga tridactylites** found a sanctuary; also the extermination of the green hound's tongue, **Gynoglossum montanum**, owing to the old quarry in which it grew being turned into a dumping ground for rubbish.

It has already been stated that plants are sometimes exterminated by purely natural causes, as the drying up of our smaller lochs and marshes. Perhaps no better example of this could be found than Arnbathy loch, that small sheet of water situated up amongst the Sidlaw Hills, near the farm of Arnbathy. This place was well known to the older botanists of the Society, and receives mention not infrequently in White's "Flora of Perthshire." Thirty years ago the buck bean, **Menyanthes trifoliata** Linn., filled the loch, affording a beautiful sight in early summer, when the plant was in bloom. Around the margin of the water many carices grew, amongst which the pretty **Carex limosa** was abundant. Within recent years a third of the area of the loch has become dry, and covered with grass; and even in the other part islands are beginning to appear in summer, and at no distant date the loch will cease to exist. With the shrinkage of the water the carices are disappearing. **Carex limose** has greatly declined, and will soon cease to appear. As some compensation, another plant has appeared on the dry portion of the loch, which had not been seen in the locality before. This is the Grass of Parnassus, **Parnassia palustris** L.

Under this heading also may be mentioned the extermination of **Lysmachia thyrsiflora** on the river bank. This plant is abundant in some of the lochs near Blairgowrie, but is rather a rare plant. A number of years ago it appeared on a marshy flat on the Tay bank below the town. The place seemed entirely suitable, and the plant increased, and looked like being a permanent resident, but the coincidence of a spate in the river with a high tide buried it under an accumulation of water wrack, from which it never emerged. I have only mentioned these facts which have come under my own observation, and which I believe to be typical of many incidents and changes incidental to a closely populated country, and also of purely natural causes which are in universal operation.

XXI.—*Recent Additions to the List of Perthshire Plants.*

By J. R. MATTHEWS, M.A.

(Read March 11, 1927.)

Fifteen years have passed since the late Mr Barclay contributed a paper to the Proceedings of this Society in which he brought together the additions that had been made to the list of Perthshire plants since the publication of Dr White's "Flora" in 1898. During the interval which has elapsed, numerous "new records" have been published in the pages of various journals, and the collation of these and their publication in one place may be useful as a further supplement to the county. Flora.

It is testimony to the thoroughness with which the *Flora of Perthshire* was originally prepared that very few species as understood by the older botanists have been added to the county list since the work was published thirty years ago, and this despite the fact that during the interval a very considerable amount of field work has been accomplished, both by local and visiting botanists. The intensive study of certain genera has resulted in the recognition of numerous segregates, and the additions are largely in the nature of these micro-species, or they are varieties of well-known species. On the other hand, some are simply adventive plants which may or may not become permanently established within the county.

For the majority of the records we are indebted to the annual Reports of the Botanical Exchange Club of the British Isles and the Watson Botanical Exchange Club. The following papers, dealing more especially with Perthshire plants, have also appeared since the date of Mr Barclay's communication: "Notes on Mid-Perth Plants," by J. R. Matthews, in Journ. Bot., 1913; "Notes on Some Plants of Mid-Perth," by E. S. Marshall, Ibid., 1914; "Scottish Highland Plants observed in 1914," by E. S. Marshall, Ibid., 1915; and "Notes on Scottish Plants," by J. R. Matthews, in Trans. Bot. Soc. Edin., 1923. Reference should be made also to Mr Bennett's remarks on Mr Barclay's paper in the Proceedings of this Society, vol. vi., p. lxxx.

From these sources the data presented in this paper have been mainly obtained. I give the records as I find them, with a reference to the source and author of each. Numerous species whose names already appear in Dr White's "Flora" are included in the list when there is additional information regarding their local distribution or when any recent observations regarding their status seem worthy of mention. In connection with local distribution, I am indebted to Mr C. G. Matthew for several records relating chiefly to the Lowland Isla district. The general arrangement adopted is that of the Flora. Following the name of the species are given in brackets the numbers showing the Watsonian vice-counties to which the records refer. These are 87, West Perth; 88, Mid-Perth; and 89, East Perth. In the case of native species, the district distribution is then generally indicated where it supplements the information given in the Flora. The name of the area—Lowland or Highland—is expressed by making use of the initial letter only, while the name of the district is given in full. The names of species which may be regarded as native are printed in heavy type, while those of adventives are in roman type.

RANUNCULACEÆ.

Thalictrum majus Crantz. (88.)

In Dr White's "Flora" (p. 46) this is given under T. minus. In the Cambridge British Flora, where it is given specific rank, Dr Moss refers to two varieties, **dumosa** Koch and **capillare** N. E. Brown, and records both from Perthshire. A plant gathered by the shore of Loch Tay, west of Fearnan Pier, by E. S. Marshall is regarded by Mr Bennett as var. **capillare.** B.E.C. Rep., 1913, p. 443.

T. aquilegifolium Linn. (89.)

A European and North Asian species found at Edradour, near Pitlochry. Webb, B.E.C. Rep., 1924, p. 553.

Anemone ranunculoides Linn. (88.)

A European species, not native in Britain; has been known to me for many years growing in a plantation near Duncrub, Dunning. Matthews, Journ. Bot., 1913, p. 193.

Caltha radicans Forster (88.)

H. Breadalbane.

By a streamlet on the south side of Ben Lawers. E. S. Marshall, Journ. Bot., 1914, p. 164.

Aconitum compactum Reichb. (89.)

Adventive, on the banks of the Tay below Perth. Druce, B.E.C. Rep., 1918, p. 273.

NYMPHÆACEÆ.

Nymphaea occidentalis (Ostenf.) Moss (88, 89.)

H. Isla, Rannoch.

The plant gathered in Loch Cally (H. Isla) in 1911 by members of the Phyto-geographical Excursion and named N. alba var. occidentalis Ostenf. is given specific rank in the Cambridge British Flora. The plant has been recorded also from the Moor of Rannoch. Druce, Trans. Bot. Soc. Edin., xxvi., 1913, p. 147.

PAPAVERACEÆ.

Papaver somniferum Linn. var. hortense (Huss.) (89.)

Alien. Cultivated land near Moulin. Webb, B.E.C. Rep., 1924, p. 554.

P. Lecoqii Lamotte (89.)

Recorded from East Perth by Druce. B.E.C. Rep., 1914, p. 59.

Corydalis lutea DC. (89.)

A European species reported from Strathardle by Webb. B.E.C. Rep., 1924, p. 555.

CRUCIFERÆ.

Nasturtium sylvestre Br. (89.)

L. Isla.

Marshy backwater of Tay between Meikleour and Delvine. C. G. Matthew.

Arabis petræa Lam. (88.)

Dr Druce maintains his varietal name **grandifolia** for the Ben Laoigh plant. See B.E.C. Reps., 1914, p. 116, and 1916, p. 556. E. S. Marshall in Journ. Bot., 1918, p. 91, agrees with Druce, and points out that the plant is not the same as A. ambigua DC., as is held by some and as stated in the Appendix to White's "Flora," p. 385. See notes under this species in the "Flora," p. 60.

Sisymbrium altissimum Linn. (88, 89.)

A casual found near Dunkeld. B.E.C. Rep., 1919, p. 638. Also reported from Moulin. Webb, B.E.C. Rep., 1924, p. 556; and from Dunning Station. Matthews, Trans. Bot. Soc. Edin., xxviii., 1923, p. 170.

Erysimum cheiranthoides Linn. (87.)

Recorded from Aberfoyle. Fraser, Trans. Bot. Soc. Edin., xxvi., 1914, p. 234.

Draba rupestris Br. (88.)

H. Breadalbane.

Ekman in Arkiv för Botanik, Bd. 12, No. 7, p. 7, proposes to use the name f. **stellata** (Dickson) for the form of this species with stellate hairs on the leaves and f. **hirta** (Smith) for the form with simple or bifurcate hairs. Both forms are recorded by the author from Ben Lawers. Ewing, in the Glasgow Naturalist, iv., 1912, p. 131, records forma **laxa** Lindl. from near the summit of Lawers.

D. incana Linn. var. **confusa** (Ehrh.) (87, 88.)

This is the common variety on Ben Ledi (H. Forth). Matthews, Trans. Bot. Soc. Edin., xxviii., 1923, p. 170. Recorded also from Ben Heasgarnich (Breadalbane) by Ewing, Glasgow Naturalist, iii., 1911, p. 31. According to Ewing, the common form on the Breadalbane range is f. **stricta** Hartm.

Alyssum incanum Linn. (89.)

Recorded from Pitlochry. Webb, B.E.C. Rep., 1924, p. 555.

Cochlearia micacea E. S. Marshall (88.)

H. Breadalbane.

Ben Lawers, Meall Garbh, and Creag Mohr. Marshall, Journ. Bot., 1914, p. 164.

VIOLACEÆ.

Viola episila Ledeb. var. **glabrescens** (88.)

H. Breadalbane.

Crianlarich. Druce, B.E.C. Rep., 1916, p. 474.

V. tricolor Linn. and **V. arvensis** Murr. (88.)

For an account of the British Pansies see Dr Drabble's paper published as a supplement to Journ. Bot., 1909, and subsequent papers by the same author in Journ. Bot., 1926, p. 263, and 1927, p. 42. The following segregates have been recorded from Lowland Earn. Matthews, Trans. Bot. Soc. Edin., xxviii., 1923, p. 170—**V. Lloydii** Jord., **V. lepida** Jord., **V. agrestis** Jord. (also from Killin. Fraser, B.E.C. Rep., 1924, p. 560), **V. segetalis** Jord., **V. obtusifolia** Jord., and **V. derelicta** Jord. (also from Killin. Drabble, loc. cit., 1909, p. 21). The pansy is widely distributed in Perthshire, and no doubt many of its micro-species are to be found in most of the districts, but the local distribution requires investigation.

CARYOPHYLLACEÆ.

Silene Cucubalus Wib. var. **rubra** DC. (88.)

On the shingly border of Loch Tay, near Fearnan (Breadalbane). Druce, B.E.C. Rep., 1915, p. 188.

Cerastium triviale Link.

The alpine specimens mentioned in the "Flora" (p. 80) may be referable to var. **alpinum** Gren., which is not uncommon in alpine situations, ascending to 1067 m. in Perthshire. Druce, Camb. Brit. Flora, iii., p. 49.

C. alpinum Linn. (88.)

The variety **pubescens** Syme referred to in the "Flora" (p. 81) is regarded by Druce (Camb. Brit. Flora, iii., p. 46) as a mixture of **C. alpinum x arcticum** and **C. alpinum x vulgatum.** Both hybrids are recorded from Ben Lawers.

Sagina subulata Presl. (89.)

H. Atholl.

Summit of pass, 1488 ft., Dalnaspidal. Druce, B.E.C. Rep., 1925, p. 867.

S. scotica Druce (87, 88, 89.)

H. Forth, Isla, Breadalbane.

The plant referred to in Mr Barclay's paper (p. cli.) as having been gathered on Ben Lawers at the time of the Phytogeographical Excursion in 1911 has provoked some discussion. In the New Phytologist, 1911, p. 310, Druce named the plant Sagina glabra var. scotica Druce. In the same journal, 1912, p. 177, Ostenfeld referred it to S. procumbens x saginoides, a view shared by Lindman. After further study, Druce concluded that the plant could not come under S. glabra, but established it as a distinct species, S. scotica Druce, in B.E.C. Rep., 1911, p. 14. A further account is given by the same author in Journ. Bot., 1913, p. 89, and in the same journal (p. 142) E. S. Marshall erpresses the opinion that the plant is a distinct species and not a hybrid. A different view is advanced by Dr Moss in Journ. Bot., 1914, p. 57. In an account of Sagina saginoides he reaches the conclusion that this species has two varieties, (a) var. macrocarpa Beck and (b) var. typica Beck. The second variety, he contends, includes S. scotica Druce. This view is adopted in Camb. Brit. Flora, iii., p. 28. On the other hand, F. N. Williams, in his revision of the British species of Sagina in B.E.C. Rep., 1917, p. 199, retains S. scotica as a species; so also does Wilmott in Babington's British Botany, 1922, p. 577.

Possibly the earliest example is a specimen from Ben Lawers, collected by Brown in 1794, in Herb. Brit. Mus., under the name Spergula subulata. This gathering is quoted by Williams, who gives also Craig Chailleach, Glas Thulachan, and Stuick an Lochan as localities. Mr Marshall records it in Journ. Bot., 1913, p. 142, from Craig an Lochan, near Killin.

HYPERICINEÆ.

Hypericum quadrangulum var. **punctatum** (Schinz.) (87.)

By the Teith, Callander (L. Forth). Druce, B.E.C. Rep., 1918, p. 496.

GERANIACEÆ.

Geranium nodosum Linn. (88.)

A casual near Dunning. Matthews, Trans. Bot. Soc. Edin., xxviii., 1923, p. 171.

PAPILIONACEÆ.

Melilotus officinalis Lam. (89.)

A colonist near Pitlochry. Druce, B.E.C. Rep., 1913, p. 210.

Trifolium striatum Linn. var. **erectum** Leight. (89.)

Near Errol. (Miss Todd.) Druce, B.E.C. Rep., 1916, p. 480.

ROSACEÆ.

Prunus insititia Linn. (88.)

Near Killin (Breadalbane). Druce and Fraser, B.E.C. Rep., 1920, p. 121. Dr White regarded the plant as probably introduced in Perthshire.

Potentilla norvegica Linn. (88.)

A casual near Birnam. Menzies, Proc. P.S.N.S., vii., 1919, p. x. Also near Dunning Station. Matthews, Trans. Bot. Soc. Edin., xxviii., 1923, p. 171.

Alchemilla vulgaris Linn.

The following micro-species of this aggregate have been recorded:—

A. pratensis Schmidt (87, 88, 89.)

Recorded for the three Watsonian vice-counties by C. E. Salmon. Journ. Bot., 1914, p. 289.

A. minor Huds. (88, 89.)

Recorded by Salmon (loc. cit.), who gives also the variety **filicaulis** (Buser) from near Caputh Bridge. In a recent paper (Journ. Bot., 1925, p. 223) Mr Salmon states that **A. minor** Huds. is the **A. filicaulis** Buser f. **vestita** Buser, and that he has gathered the typical plant near Dalnaspidal.

A. tenuis Buser (88, 89.)

Meall Greigh and Sow of Atholl; streamside near Dalnaspidal. C. E. Salmon, Journ. Bot., 1925, p. 226. The Meall Greigh plant was recorded in Journ. Bot., 1914, p. 289, as A. minor var. filicaulis.

A. alpestris Schmidt (87, 88, 89.)

Recorded for the three vice-counties by Salmon. Journ. Bot., 1914, p. 289; and from Callander (87) by Druce. B.E.C. Rep., 1925, p. 872.

A. acutidens Buser (87, 88.)

This was first noticed in Britain by Dr Ostenfeld on Ben Lawers on the occasion of the International Phyto-geographical Excursion in 1911. Careful study of the material convinced Mr Salmon that the British plant is not true acutidens, and he established the variety **alpestriformis** C. E. Salmon, in Journ. Bot., 1914, p. 281, to cover the British form. It is recorded (loc. cit.) from Ben Lawers, Ben Lui, Meall nan Tarmachan, Meall Garbh, Gleann Muilinn near Fortingall, and (Journ. Bot. 1920, p. 113) from Beinn a Chroin, Glen Falloch.

A. firma Buser (88.)

Two examples which Mr Salmon had labelled A. acutidens, gathered in 1913 on Ben Lawers, have been determined by Dr Jaquet as A. firma Buser. Journ. Bot., 1925, p. 228.

A. glomerulans Buser (88, 89.)

According to Wilmott in Journ. Bot., 1922, p. 164, a specimen in the herbarium of the late E. S. Marshall is this species. It was gathered by a streamlet on the south side of Ben Lawers, 1800-3000 ft., 1913. It is recorded also from Dalnaspidal. C. E. Salmon, Journ. Bot., 1925, p. 227.

A. connivens Buser (89.)

Near Dalnaspidal at about 2500 ft. C. E. Salmon, Journ. Bot., 1925, p. 228.

A. argentea G. Don (**A. conjuncta** Bab.) (88, 89.)

The history of this plant in Britain is given by Dr Druce in B.E.C. Rep., 1917, p. 20. A specimen in Herb. Druce is said to be from a root collected on Ben Lawers, J. Morley, 1871; see Report for 1914, p. 66. In the Report for 1918, p. 282, Druce states that a specimen labelled A. alpina, gathered by Thomson near Ballinluig in 1877, is A. argentea, and thus admits it as native in 89, East Perth. The plant was long known to the late Mr Barclay, growing on a railway embankment near Perth, and in that station we were both of the opinion that it might be a garden escape. The plant is frequently grown in cottage gardens.

Agrimonia Eupatoria Linn. var. **sepium** Bréb. (88.)

Cliffs above Fortingal, 500 to 1100 ft. E. S. Marshall, Journ. Bot., 1914, p. 165.

A. odorata Mill. (88.)

H. Breadalbane.

Fortingal. E. S. Marshall, Journ. Bot., 1915, p. 338.

x **Rosa Barclayi** W.-Dod. (**R. spinosissima x omissa**) (88.)

The Auchterarder plant referred to in the "Flora" (p. 133) under R. involuta Sm. var. Sabini Woods has been described under the above name by Col. Wolley-Dod in Journ. Bot., 1924, p. 203. It is a unique form of the series of hybrid roses included under R. involuta Sm.

R. pomifera Herrm. (88.)

Keltney Burn (Breadalbane). R. W. Butcher, B.E.C. Rep., 1925, p. 873.

SAXIFRAGACEÆ.

Saxifraga tridactylites Linn. (88.)

H. Earn.

Boltachan. Haggart, Trans. P.S.N.S., vi., p. 181, 1917. An interesting extension in the range of this rare and local plant in Perthshire.

HALORAGACEÆ.

Callitriche stagnalis Scop. (88.)

L. Earn.

Small stream west of Dunning and R. Earn above Dalreoch Bridge. The variety **serpyllifolia** Lönnr. is common in the Muir Wood, Dunning. Matthews, Trans. Bot. Soc. Edin., xxviii., 1923, p. 171.

C. intermedia Hoffm. var. **homoiophylla** Gren. et Godr. (88.)

Deep pool in Leadketty Burn, Dunning. Matthews, loc. cit., p. 171. Also in deep water at Milton of Morenish, Loch Tay. Fraser, B.E.C. Rep., 1919, p. 655.

C. pedunculata DC. (88.)

L. Earn.

Burnside near Leadketty Farm, Dunning. Matthews, loc. cit., p. 171.

ONAGRARIEÆ.

x **Epilobium erroneum** Haussk. (88.)

This hybrid (E. hirsutum x montanum) was observed on waste ground at Perth by Barclay and Druce. B.E.C. Rep., 1916, p. 486.

E. roseum Schreb. (88.)

Recorded from Mid-Perth without exact locality. B.E.C. Rep., 1914, p. 66. See note in "Flora" (p. 155) under E. palustre Linn.

UMBELLIFERÆ.

Apium graveolens Linn. (87, 89.)

Recorded as native in vice-counties 87 and 89 by H. J. Riddelsdell in Journ. Bot., 1914, p. 340.

Pimpinella Saxifraga Linn. var. **dissectifolia** Wallr. (88, 89.)

Near Guildtown (L. Isla). C. G. Matthew; near Dunning (L. Earn). J. R. Matthews.

Peucedanum Ostruthium Koch (88, 89.)

Below Abercairney (L. Earn). Barclay, Proc. P.S.N.S., vi., 1919, p. cxcv. Roadside near Wolfhill (L. Isla). C. G. Matthew. A European species not native in Perthshire.

Anthriscus sylvestris Hoffm. var. **angustisecta** Druce (87, 88, 89.)

Recorded from Methven, Glen Farg, Callander, and Blair Atholl by Dr Druce. See B.E.C. Reps., 1916, p. 413 (where the variety is described), 1918, p. 381, and 1925, p. 876. Two varieties of this common plant have been described by Druce—viz., **latisecta** and **angustisecta.** The former seems to be the prevailing form in the south, while the latter seems to be northern in its distribution.

Levisticum officinale Koch (88.)

A European species long established at Dunning (apparently a relic of cultivation), now spreading down the burn from its original station in the village. Matthews, Journ. Bot., 1913, p. 193.

CORNACEÆ.

Cornus suecica Linn. (87.)

H. Forth.

This local plant recorded in the "Flora" (p. 165) for vice-counties 88 and 89, was found on Ben Ledi (87) by Prof. J. H. Balfour on the occasion of his first class excursion to that mountain in 1860 and again on several subsequent visits. The plant still grows on the hill in small quantity. The early records must have escaped the notice of Dr White. The omission from the "Flora" was pointed out by W. Evans in Trans. Bot. Soc. Edin., xxvi., 1913, p. 98.

RUBIACEÆ.

Galium boreale Linn. forma **diffusum** Druce (87.)

Callander. Druce, B.E.C. Rep., 1925, p. 774.

G. palustre Linn. var. **elongatum** (Presl.) (88.)

River Earn near Dalreoch Bridge. Matthews, Trans. Bot. Soc. Edin., xxviii., 1923, p. 172.

COMPOSITÆ.

Aster Novi-Belgii Linn. (88.)

Banks of the Earn. Matthews, Trans. Bot. Soc. Edin., xxviii., 1923, p. 172. Lochyside. Webb, B.E.C. Rep., 1921, p. 384.

Inula Conyza DC. (89.)

Kinnoull Hill. D. Campbell, Trans. P.S.N.S., viii., 1926, p. 155.

Gnaphalium sylvaticum Linn. var. **spadiceum** (Gilib.) (89.)

Glen Shee. Druce, B.E.C. Rep., 1915, p. 200.

Chrysanthemum macrophyllum Waldst. et Kit. (88.)

Collected near Bridge of Earn and sent to me for identifition by Mr Ritchie, July, 1923.

Senecio viscosus Linn. (88.)

H. Lomond.

On the railway embankment, Glen Falloch. See Glasgow Naturalist, v., 1913, p. 99.

Doronicum plantagineum Linn. (88.)

Grounds of Duncrub, probably an escape. Matthews, Journ. Bot., 1913, p. 194.

Bidens cernua Linn. (88.)

L. Perth.

Methven Loch. Dow, Proc. P.S.N.S., vi., 1914, p. xli.

Arctium vulgare subvar. **pycnocephalum** Evans (89.)

Recorded for East Perth by A. H. Evans in Journ. Bot., 1915, p. 147.

Centaurea nigra Linn.

This is now regarded as an aggregate species. The segregates recognised in Britain have been described by C. E. Britton in B.E.C. Rep., 1921, p. 406. **C. nemoralis** Jord. var. **subintegra** Britton has been recorded from Tayside, Perth. B.E.C. Rep., 1922, p. 732, and **C. obscura** Jord. from Keltney Burn. Druce, B.E.C. Rep., 1923, p. 192.

Carduus (Cnicus) palustris var. **ferox** Druce (88.)

Ben Lawers, Dunkeld, and Corrie Ardran. B.E.C. Reps., 1911, p. 22, and 1916, p. 491.

C. heterophyllus Linn. (88.)

H. Lomond.

Glen Falloch. Lee, Glas. Nat., vii., 1915, p. 70.

Sonchus asper Hoffm. var. **integrifolius** Wallr. (88.)
Lochearnhead. Druce, B.E.C. Rep., 1920, p. 133.

Taraxacum.

Many micro-forms of the Dandelion have been described within recent years, but it is not yet possible to give an account of Perthshire specimens. The following have been recorded:—

T. spectabile Dahlst. (88.)

Meall Garbh and Creag Mohr (Breadalbane). E. S. Marshall, Journ. Bot., 1914, p. 165.

T. faeroense Dahlst. (88, 89.)

Glen Shee (H. Isla) and Ben Heasgarnich (Breadalbane). B.E.C. Rep., 1922, p. 735. Also from Ben Lawers. Druce, Trans. Bot. Soc. Edin., xxix., 1924, p. 6.

Crepis capillaris var. anglica Druce et Thellung (88, 89.)

Bruar, E. Perth, and Lawers, M. Perth. B.E.C. Rep., 1925, p. 881.

C. succisaefolia Tausch. (88.)

H. Breadalbane.

North of Garth Castle, and in Glen Lyon about four miles above Fortingal. E. S. Marshall, Journ. Bot., 1914, p. 165.

Hieracium.

A bewildering multiplication of names characterises recent work on the genus Hieracium. Thus, in the eleventh edition of the London Catalogue of British Plants (1925) there appear the names of nearly 250 "species" of Hawkweed—about 11 per cent. of the total number of British Flowering Plants. The arrangement adopted is that of the recent monograph on the genus by Zahn in Engler's Pflanzenreich (1923), and in the following additions to the Perthshire list the same sequence is maintained. In the case of Perthshire specimens quoted by Zahn the exact locality is not always stated, but I include the names here since they appear entitled to a place in the county list.

H. rubicundiforme Zahn (88.)

Recorded under H. rubicundum F. J. H. by E. S. Marshall from stream sides in Fin Glen (Breadalbane). Journ. Bot., 1914, p. 166.

H. scoticum F. J. Hanb.

Perthshire. Zahn's Monograph, p. 206.

H. crassiceps Dahlst.

Perth. loc. cit., p. 303.

H. subulatidens Dahlst. (88.)

Allt Odhar at 1700 ft. (Breadalbane). Marshall, Journ. Bot., 1914, p. 166.

H. Shoolbredi E. S. Marshall (88. 89.)

Hillside, Sgairneach Mor and Coire Chuirn, adjoining Atholl Forest. Full account by Marshall in Journ. Bot., 1913, p. 121.

H. Killinense Zahn (88.)

Killin. Zahn's Monograph, p. 338.

H. Lintoni Ley.

Rannoch. Druce, B.E.C. Rep., 1921, p. 387.

H. orithales E. F. Linton (88.)

Meall na Saone (Breadalbane). Described as a new species in Journ. Bot., 1911, p. 355.

H. expallidiforme Dahlst.

Perth. Zahn's Monograph, p. 347.

H. cordigerum Norrl. var. **asymmetricum** Ley (88.)

Falloch River (Lomond). E. S. Marshall, Journ. Bot., 1915, p. 160, where it is recorded under H. silvaticum.

H. cravoniense F. J. Hanb.

Perth. Zahn's Monograph, p. 440.

H. farrense F. J. Hanb. (88.)

Shady ravine 300 yards north of Garth Castle. E. S. Marshall, Journ. Bot., 1914, p. 166.

H. eustales Linton (88.)

Possibly this, north side of Meall Garbh and Fin Glen, Glen Lyon. W. A. Shoolbred, B.E.C. Rep., 1913, p. 479. Recorded from Perthshire by Zahn, p. 448. In 1891 the plant was gathered on the Glen Lyon side and on Meall na Saone on rocky sides of the Allt Dubh Galair. It was overlooked in the list supplied by Mr Hanbury for the "Flora."

H. duplicatum Almq. var. **stenophyes** W. R. Linton (88.)

West side of Ben More at 2500 ft. E. S. Marshall, Journ. Bot., 1911, p. 193.

H. holophyllum W. R. Linton

Perth. Zahn's Monograph, p. 464.

H. Isabellae E. S. Marshall (88.)

Allt Coire Luidhearnaidh, west of Dalnaspidal and north of Loch Garry (Atholl). Described as a new species by E. S. Marshall in Journ. Bot., 1913, p. 119.

H. callistophyllum F. J. H. var. **glandulosum** F. J. H. (88.)

Beinn a Chroin (Lomond) and Ben Chaluim (Breadalbane). E. S. Marshall, Journ. Bot., 1915, p. 160.

H. pulmonariodes Vill. (88.)

Not native. On an old wall near Kenmore. H. W. Pugsley, Journ. Bot., 1920, p. 281.

H. perthense Williams (89.)

This name now stands for the Glen Shee plant referred to in the "Flora," p. 203, as **H. dovrense** Fr. var. **spectabile** Marshall.

H. stictophyllum Dahlst.

Perth. Zahn's Monograph, p. 871.

H. sparsifolium Lindeb. (88.)

North-east end of Loch Tummel. E. S. Marshall, Journ. Bot., 1914, p. 167.

H. acrifolium Dahlst.

Perth. Zahn's Monograph, p. 879.

H. umbellatum var. **linariifolium** Wallr. (88.)

Near Fortingal. E. S. Marshall, Wat. Bot. Exc. Club Rep., 1913-14, p. 449.

H. subumbellatiforme Zahn (88.)

Linn of Campsie (L. Perth). Zahn's Monograph, p. 919.

H. trichophyton Almq. var. **glandulosum** F. J. H. (88.)

Fortingal and Lochearnhead. loc. cit., p. 923.

H. obliquum Jord. (87.)

Loch Katrine. loc. cit., p. 946.

H. concinnatum F. J. Hanb. (89.)

Recorded by Druce for v.c. 89 under H. pilosella var. concinnatum F. J. H. B.E.C. Rep., 1925, p. 881.

VACCINIACEÆ.

Oxycoccus quadripetala Gilib. var. **microcarpus** (Turc.) (89.)

Flowering specimens from Glen Shee, 1883 (Druce) is (teste Prof. Lindman) probably this. B.E.C. Rep., 1913, p. 389. Var. **pyriformis** Dr. is recorded by Druce from Methven (v.c. 88). B.E.C. Rep., 1918, p. 289.

ERICACEÆ.

Ledum palustre (87.)

"The claims of this plant . . . to be considered native in Scotland are discussed and regarded as probably valid, by Mr Bennett, in Journ. Bot., 1894, pp. 274-275." See "Flora," p. 388. For further notes regarding this plant see Journ. Bot., 1925, p. 148 and p. 178, and 1926, p. 61.

GENTIANACEÆ.

Gentiana campestris Linn. var. **suecica** Murb. (89.)

Specimens collected by Salmon near the Spital of Glen Shee in 1912 were determined as this variety by Dr Murbeck. C. E. Salmon, Journ. Bot., 1923, p. 88.

G. Amarella Linn. (88.)

Between Tay and Tummel (Atholl). Druce, B.E.C. Rep., 1915, p. 274. The station is not far from the Blair Atholl localities mentioned in the "Flora" and in Barclay's List. In 1917 Mr Barclay found the plant in considerable quantity along both sides of the road near Loch Moraig. Proc. P.S.N.S., vi., 1919, p. cc.

BORAGINACEÆ.

Symphytum officinale Linn. var. patens Sibth. (88.)

Plentiful on south side of Steelend Den, Dunning. Matthews, Journ. Bot., 1913, p. 194.

S. peregrinum Ledeb. (89.)

An alien recorded by Fraser from Blair Atholl and River Tay below Perth. B.E.C. Rep., 1914, p. 84, and Trans. Bot. Soc. Edin., 1914, p. 234.

Anchusa sempervirens Linn. (88.)

Several places near Dunning. Matthews, Journ. Bot., 1913, p. 194.

OROBANCHACEÆ.

Lathræa squamaria Linn. (88.)

H. Breadalbane.

Near Garth Castle and near Killin Pier. Haggart, Trans. P.S.N.S., vi., 1915, p. 50.

SCROPHULARIACEÆ.

Scrophularia vernalis Linn. (88.)

Abundant near Duncrub. Matthews, Journ. Bot., 1913, p. 195.

Mimulus moschatus Dougl. (88, 89.)

Naturalised in Glen Lyon. Miss Todd, B.E.C. Rep., 1925, p. 887. Backwaters of River Tay above Meikleour. C. G. Matthew.

Veronica officinalis Linn. var. **glabrata** Bab. (88.)

Meall Farrnin Chor, above Appin. Haggart, B.E.C. Rep., 1916, p. 496.

Euphrasia officinalis Linn. (87, 88, 89.)

The aggregate species is common throughout the three vice-counties. The following micro-species are recorded by Bucknall in his account of the British Euphrasiæ in Journ. Bot. Supp., 1917.

E. brevipila Burnat et Gremli (88, 89.)

Ben Laiogh. Also reported from Dunkeld and Moor of Rannoch by Druce in Trans. Bot. Soc. Edin., xxvi., 1913, p. 149.

E. curta Fries (88.)

Ben Laiogh; Cruach Ardran; Crianlarich and Tyndrum.

E. fennica Kihlm. (88.)

Slopes near Lawers Burn.

E. Rostkoviana Hayne (88.)

Meadow at foot of Ben Lawers. Also Kinloch Rannoch. Druce, Trans. Bot. Soc. Edin., xxvi., 1913, p. 149.

Rhinanthus stenophyllus Schur. (88.)

H. Breadalbane, Atholl.

Meadows by River Dochart above Crianlarich. E. S. Marshall, Journ. Bot., 1915, p. 160. Dalnaspidal. Druce, Journ. Bot., 1903, p. 360.

R. monticola Druce (89.)

H. Isla.

Glas. Thulachan. Druce, Journ. Bot., 1903, p. 360.

R. borealis Druce (88.)

H. Breadalbane.

An Caisteal. E. S. Marshall, Journ. Bot., 1915, p. 160; and Ben Laoigh. Druce, B.E.C. Rep., 1916, p. 497.

Melampyrum.

An account of the British species of Melampyrum as dealt with by M. Beauverd in his monograph of the genus is given in B.E.C. Rep., 1917, pp. 40-48. Reference may also be made to Hayward's Botanist's Pocket Book, 18th Edit., 1926, p. 280.

M. pratense Linn. var. **paludosum** Gaud (88.)

Inch Garth. B.E.C. Rep., 1917, p. 42.

var. **montanum** Johnst. (88.)

Ben Lawers. loc. cit., p. 43.

var. **ericetorum** D. Oliver (88.)

Bushy hillock east of Garth Castle. Marshall, Journ. Bot., 1914, p. 167.

var. **hians** Druce (89.)

Reported from Blairgowrie.

M. sylvaticum Linn. var. **nephelobium** (Beauv.) (88.)

Coshieville and Lawers. B.E.C. Rep., 1917, p. 47. In B.E.C. Rep., 1915, p. 206, Dr Druce expresses the opinion that the name **pallidiflorum** B. White used for the pale-coloured variety of this species from Glen Tilt is antedated by that of var. **pallens** Huserdorfer.

LABIATAE.

Mentha rotundifolia Huds. (88.)

H. Breadalbane.

On left bank of Dochart. Fraser and Haggart, B.E.C. Rep., 1919, p. 672.

M. longifolia var. **mollissima** (Borkh.) (89.)

Banks of the Isla near Meigle. Cowan, Wat. B.E.C. Rep., 1912-13, p. 404.

var. **nemorosa** (Willd.) (88.)

Dunning Burn, L. Earn. Matthews, Trans. Bot. Soc. Edin., xxviii., 1923, p. 172.

M. spicata Linn. (87.)

Callander, L. Forth. Druce, B.E.C. Rep., 1925, p. 889.

M. piperita Linn. (88.)

Established near the Lyon below Fortingal. E. S. Marshall, Journ. Bot., 1914, p. 167.

M. aquatica Linn. (88.)

The varieties **minor** Sole and **major** Sole are not uncommon in several places near Dunning. Matthews, Trans. Bot. Soc. Edin., xxviii., 1923, p. 172.

M. sativa Linn.

This is a series of hybrid forms between **M. aquatica** and **M. arvensis.** Numerous varieties have been described.

var. **ovalifolia** Opiz and var. **acutifolia** Sm. are not uncommon near Dunning and on the banks of the Earn. Matthews, loc. cit., p. 172.

var. **obtusata** Opiz is recorded from the banks of the Isla by Cowan. Wat. B.E.C. Rep., 1912-13, p. 405.

M. rubra Sm. (88.)

H. Breadalbane.

Dochart Bridge; Milton of Morenish; Craignavie. Fraser and Haggart. B.E.C. Rep., 1919, p. 673.

M. gentilis Linn. (87, 88.)

L. Forth. H. Breadalbane.

Callander. Druce, B.E.C. Rep., 1918, p. 393.

var. **variegata** (Solé)

Tyndrum. Rev. H. Harvey, B.E.C. Rep., 1925, p 889.

M. arvensis var. **Nummularia** (Schreb.) (88)

Near Dunning. Matthews, Trans. Bot. Soc. Edin., xxviii., 1923, p. 173.

Lycopus europæus Linn.

L. Isla.

Backwater of Tay above Meikleour. C. G. Matthew.

Thymus.

In an account of this genus by Dr K. Rönniger in B.E.C. Rep., 1923, pp. 226-239, the following forms are recorded from the county:—

T. pycnotrichus Uechtr., from Struan (89); **T Drucei** Ronn., from Ben Laoigh (88); **T. neglectus** Ronn. from Tummel (88); and **T. britannicus** Ronn., from Ben y Vrackie (89). A key to the genus is given in Hayward's Botanist's Pocket Book, 18th Edit., 1926, p. 281.

LENTIBULARIACEÆ.

Utricularia minor Linn.

A specimen in Perth Herb. collected by Sturrock is var. **platyloba** Meister (teste Glück). A. Bennett, Journ. Bot., 1914, p. 9.

PRIMULACEÆ.

Lysimachia vulgaris Linn. (89.)

L. Isla.

In swamp below Delvine House. C. G. Matthew.

L. Nummularia Linn. (88.)

Duncrub, L. Earn, not native. Matthews, Journ. Bot., 1913, p. 194.

PLANTAGINACEÆ.

Plantago maritima Linn. (88, 89.)

For an account of this polymorphic species see B.E.C. Rep., 1920, p. 36, and for a description of a montane variety named **Hudsoniana** Druce, reported from Ben Laoigh, see B.E.C. Reps., 1912, p. 170, and 1916, p. 499. The form **procerior** Lange, equivalent to var. **tenuifolia** Hartm. is recorded by M'T. Cowan from Glen Isla. Wat. B.E.C. Rep., 1911-12, p. 356.

POLYGONACEÆ.

Polygonum Bistorta Linn. (87, 88.)

Established in several places near Dunning. Matthews, Journ. Bot., 1913, p. 195. Druce records var. album from Callander. B.E.C. Rep., 1925, p. 892.

P. cuspidatum S. et Z. (87, 88.)

Alien. Callander and Tayside. B.E.C. Rep., 1918, p. 397.

P. aviculare Linn.

This has been separated by Lindman into two species, **P. heterophyllum** Lindm. and **P. æquale** Lindm. Both are common in Lowland Earn (88) and doubtless both occur in most if not all the districts. The former is recorded from Callander (87), Lawers (88), and Dunkeld (89), and the latter from Callander (87) and Perth (89). Druce, Trans. Bot. Soc. Edin., xxvi., 1913, p. 150. P. æquale is common in Glen Lyon (88). E. S. Marshall, Journ. Bot., 1914, p. 167.

CUPULIFERÆ.

Betula alba x pubescens var. **microphylla** E.S.M. (88.)

West of Garth Castle, near Fortingal. E. S. Marshall and C. E. Moss, B.E.C. Rep., 1913, p. 496.

SALICINEÆ.

Salix.

The following records are taken from the Rev. E. F. Linton's account of the genus published as a Supplement to the Journal of Botany, 1913. The page references, given in brackets, are those of the Supplement. The name **Andersoniana** now replaces **nigricans,** which is used in the Flora of Perthshire.

S. alba x triandra (undulata Ehrh.)

S. undulata, recorded from Perthshire by Linton (p. 20), has been confused with S. hippophæfolia Thuill (S. triandra x viminalis) and is recorded under this parentage in the " Flora," p. 269. Buchanan White's S. subdola (triandra x alba) is regarded by Linton as a form of S. viridis (alba x fragilis).

S. aurita x purpurea (dichroa Döll.)

Perthshire. Hb. B. White (p. 23).

S. aurita x cinerea x purpurea (confinis Camus).

Riverside near Perth (p. 24).

S. lapponum x phylicifolia (Gilloti Camus).

On rocks two miles north of Ben Lawers (p. 37).

S. aurita x cinerea x Andersoniana.

To this parentage Linton refers specimens collected by Buchanan White near Perth. Hb. B. White 415, 442 as S strepida (p. 42).

S. aurita x lapponum (Læstadiana Hartm. p.p.).

Mid and East Perth (p. 43).

S. aurita x myrsinites x Andersoniana.

Glen Lyon near Fortingal (p. 44).

S. aurita x Andersoniana x phylicifolia (saxetana B.W. p.p.).

Roadside, ½ ml. west of Killin and Glen Shee (p. 45).

S. caprea x lapponum (Læstadiana Hartm.).

By the Lochy Burn, Glen Shee, E. Perth (p. 50).

S. caprea x phylicifolia.

Perthshire specimens from Glen Shee (hb. E. S. Marshall, 712) and from Killin may with some certainty be referred to this hybrid (p. 52).

S. Andersoniana x arbuscula.

On Ben Lawers and on rocks above Lochan na Lairige, low down on Meall nan Tarmachan (p. 64).

S. Andersoniana x arbuscula x phylicifolia.

This triple hybrid has been obtained from Meall Taurnie, Sgiath Chrom and the lower rocks of Meall nan Tarmachan above Lochan na Lairige, all in Breadalbane. Not known elsewhere in Britain. Discovered by P. Ewing (p. 64).

S. Andersoniana x myrsinites x phylicifolia.

Meall Ghaordie (p. 66).

S. Andersoniana x herbacea?

A plant from Meall Ghaordie, which Dr. White regarded as S. reticulata x Andersoniana (semi-reticulata B.W.), is considered by Linton to be more probably a hybrid with herbacea as the second parent (p. 65).

S. phylicifolia x repens (Schraderiana Willd.).

Glen Shee (p. 71).

S. lanata x **reticulata.**

In a corrie on the north side of Meall na Saone. Linton excludes White's specimen referred to this parentage under the name S. superata B.W., and gives Enander's opinion in favour of herbacea x lanata (p. 76).

S. herbacea x **lapponum (sobrina** B. White).

Add Meall na Saone and Meall Garbh to the single record in the "Flora" (p. 80).

S. herbacea x **myrsinites (Grahami** Baker).

In addition to the Sow of Atholl specimen mentioned in the "Flora," a plant gathered on Meall na Saone in 1891 is probably this hybrid (p. 82).

S. herbacea x **repens (cernua** Linton).

In 1896, E. S. Marshall found three plants, including forma microphylla, by the Lochy Burn, Glen Shee. The hybrid is endemic in Scotland (p. 85).

S. herbacea x **reticulata.**

Meall Ghaordie (p. 85).

S. lapponum Linn.

H. Lomond.

Found on An Caisteal at 2800 ft. Lee, Glas. Nat., vii., 1915, p. 74.

CONIFERÆ.

Juniperus communis var. **intermedia** Nyman (88.)

Ben Heasgarnich. M'T. Cowan, Wat. B.E.C. Rep., 1911-1912, p. 362.

HYDROCHARIDEÆ.

Stratiodes Aloides Linn. (88.)

For an account of this species found in a pond near Crieff, see Davie in Trans. Bot. Soc. Edin., xxvi., 1913, p. 180.

ORCHIDACEÆ.

Malaxis paludosa (88.)

H. Lomond.

Near Coiletter, Glen Falloch. Lee, Glas. Nat., viii., 1926, p. 199.

Cephalanthera ensifolia Rich. (88.)

This rare species is still known to occur in Methven Woods. J. Menzies and J. Ritchie, 1927.

Orchis praetermissa Druce (89.)

H. Atholl.

Blair Atholl. Druce, B.E.C. Rep., 1921, p. 398. The variety pulchella Druce is recorded from Muthil by Tahourdin in "Some Notes on British Orchids," 1924.

O. Fuchsii Druce (88.)

H. Breadalbane.

Kenmore. Druce, B.E.C. Rep., 1915, p. 213.

For accounts of the British Dactylorchids see B.E.C. Rep., 1917, p. 149, and Journ. Bot., 1924, p. 175.

LILIACEÆ.

Polygonatum verticillatum All. (88.)

H. Breadalbane.

Banks of the Keltney Burn, near Garth Castle, associated with **Convallaria majalis.** E. S. Marshall, Journ. Bot., 1914, p. 168. Neither plant is recorded in the "Flora" from Breadalbane.

Allium Scorodoprasum Linn. (89.)

Introduced. Grassy banks and roadside below Delvine House. C. G. Matthew.

JUNCACEÆ.

Juncus effusus Linn. var. **compactus** Lej. et Court (89.)

Near Dunkeld. Druce, B.E.C. Rep., 1911, p. 35.

J. tenuis Willd. (88.)

High road from Crianlarich to Tyndrum and in Glen Falloch. E. S. Marshall, Journ. Bot., 1915, p. 161. Near Killin. P. Ewing, Glas. Nat., iii., 1911, p. 32. According to a note in B.E.C. Rep., 1921, p. 401, there is a Perthshire specimen collected by M'Intyre before 1844 in Herb. Ansell.

Luzula nemorosa Mey (L. albida DC.) (89.)

Established near Errol. Druce, B.E.C. Rep., 1916, p. 505.

ALISMACEÆ.

Alisma ranunculoides Linn. (88.)

L. Earn.

Whitemoss Loch, Dunning. Matthews, Journ. Bot., 1913, p. 195. Confirms the record in "Fl. Scot." 1821, and adds Lowland Earn to the district distribution.

NAIADACEÆ.

Scheuchzeria palustris Linn. (88.)

Moor of Rannoch. A. H. Evans, B.E.C. Rep., 1913, p. 395. Bog near Rannoch Station. E. S. Marshall, B.E.C. Rep., 1914, p. 166. For an account of the re-discovery of this rare plant in Scotland see Scarth in "Notes Roy. Bot. Gdn. Edin." No. xxii., 1911, p. 57. The plant is extinct in the Methven station mentioned in the "Flora."

Potamogeton polygonifolius var. **cordifolius** C. et S. (88.)

Ditch near Loch Tay. M'T. Cowan, Wat. B.E.C. Rep., 1911-12, p. 362. Cow's Moss, south of Dunning. Matthews, Trans. Bot. Soc. Edin., xxviii., 1923, p. 173.

P. alpinus x **gramineus** (**gracilis** Wolfg.) (89.)

Loch Moraig (Atholl). (Barclay) Bennett, Proc. P.S.N.S., vi., p. cxxv.

P. decipiens Nolte (88.)

The River Earn specimens come under var. latifolius Hagst. See note in "Flora," p. 310.

P. crispus Linn. var. **planifolius** Meyer (88.)

River Earn above Dalreoch Bridge. Matthews, Trans. Bot. Soc. Edin., xxviii., 1923, p. 173.

P. crispus x **alpinus** (**venustus** Baagöe) (88.)

L. Earn.

River Earn above Dalreoch Bridge. (Barclay and Matthews) Bennett, Proc. P.S.N.S., vi., 1916, p. cxxiv.

P. obtusifolius M. et K. var. **lacustris** Fries (89.)

Clunie Loch. (Sturrock) Bennett, Journ. Bot., 1919, p. 18.

P. panormitanus Biv. Bern. (88, 89.)

L. Earn, Isla.

Kelty Pond, Dunning. Matthews, Trans. Bot. Soc. Edin., xxviii., 1923, p. 173. Marlee Loch. A. Sturrock, 1882. A. Bennett, in litt., July, 1927.

P. tricholdes C. et S. (88.)

L. Earn.

Whitemoss Loch, Dunning. (Matthews) Bennett, Journ. Bot., 1913, p. 336.

P. pectinatus Linn. (88.)

L. Earn.

Kelty Pond, Dunning. Matthews, loc. cit., p. 173.

CYPERACEÆ.

Schoenus nigricans Linn. (89.)

In the Appendix to the "Flora," p. 389, it is stated that the occurrence of this plant in Glen Shee is confirmed. Dr Druce records in B.E.C. Rep., 1918, p. 404, that he has seen a specimen collected by Miss Thompson in 1877 at Faskally, near Pitlochry (H. Isla), also in v.-c. 89.

Rhynchospora alba Vahl. (88.)

H. Lomond.

Glen Falloch. Lee, Glas. Nat., vii., 1915, p. 70.

Scirpus caespitosus Linn. var. **germanicus** (Palla) (88.)

Moor of Rannoch. Druce, Trans. Bot. Soc. Edin., xxvi., 1913, p. 150.

Eriophorum angustifolium Roth. var. **alpinum** Gaud. (88.)

In profusion at 2300-2500 ft. north-east corrie of Ben Chaluim. E. S. Marshall, Journ. Bot., 1915, p. 161.

Carex pulicaris Linn. f. **montana** Pugl. (87, 88.)

Craig-na-Lochan, Bein Dubh Chronzie, Ben More, Ben Laoigh, all in Mid-Perth. Ben Ledi, West Perth. Matthews, Trans. Bot. Soc. Edin., xxviii., 1923, p. 173. This form is liable to be confused with the rare C. rupestris. See Pugsley, Journ. Bot., 1921, p. 106.

C. rupestris All. (89.)

Ben Bhrackie. Barren specimens were considered by Druce to be unmistakably this species. If so, the record is a new one for East Perth, v.-c. 89. B.E.C. Rep., 1915, p. 286.

C. microglochin Wahl. (88.)

H. Breadalbane.

Yellow Corrie, Glen Lyon, at about 2500 ft. Discovered by Lady Davy and Miss Gertrude Bacon, July, 1923. For an account of this addition to the list of British Sedges see Druce, B.E.C. Rep., 1923, p. 68.

C. canescens Linn. var. **fallax** F. Kurtz. (89.)

Allt a' Chama Choire, Forest of Atholl. Marshall and Shoolbred, Journ. Bot., 1913, p. 167.

C. Halleri Gunn (**C. alpina** Sw.) (88.)

Ben Heasgarnich. P. Ewing, Glas. Nat., iii., 1911, p. 32. One of our rarest sedges, and only one locality (Glen Lyon) is given in the "Flora."

C. aquatilis Wahl. (88.)

H. Rannoch.

Head of Loch Tummel. Marshall, Wat. B.E.C. Rep., 1913-14, p. 462. The variety epigeios Laest. (now regarded as aquatilis x rigida) occurs in peaty bogs at head of Allt a' Chama Choire, 2600-2700 ft. Marshall and Shoolbred, Journ. Bot., 1913, p. 167.

C. rariflora Sm. (88, 89.)

H. Breadalbane.

This is given in the "Flora" from 89 East Perth, Meall Odhar. Marshall and Shoolbred record it (Journ. Bot., 1913, p. 167) as locally plentiful in spongy bogs near the Allt a' Chama Choire, also in E. Perth. In Journ. Bot., 1916, p. 145, L. Cumming writes that he gathered this species on Ben Lawers in August, 1899. Marshall, loc. cit., p. 211, suggests that the plant was C. atrofusca (ustulata), but at p. 307 he admits that Mr Cumming's specimen is thoroughly typical C. rariflora.

C. panicea Linn. var. **tumidula** Laest. (88.)

Bog near Rannoch Station. Marshall, Journ. Bot., 1915, p. 161.

C. glauca Scop. var. **stictocarpa** (Sm.) (87, 88.)

Scone and Ben Laoigh. Druce, B.E.C. Rep., 1916, p. 507.

C. pilulifera Linn. var. **longibracteata** Lange (88.)

Ben Lawers. Miss Todd, B.E.C. Rep., 1925, p. 902.

C. fulva x Oederi (88.)

North shore of Loch Tummel. E. S. Marshall, Journ. Bot., 1914, p. 168.

C. Sadleri Linton (88.)

Corrie about Buidheag, Glen Lyon. Foggit, B.E.C. Rep., 1920, p. 155. This is now treated as synonymous with C. binervis var. alpina Drej.

C. pendula Huds. (89.)

H. Atholl.

Glen Tilt, Blair Atholl. Barclay, Proc. P.S.N.S., vi., 1916, p. cix.

C. inflata x vesicaria.

Marshes at head of Loch Tummel. E. S. Marshall, Journ. Bot., 1914, p. 168.

C. pulla Good **(saxatilis)** (88.)

Glen Lyon. Druce, B.E.C. Rep., 1923, p. 218. The variety dichroa (Fr.) occurs with the type on Beinn a Chroin and on Ben Chaluim.

C. Grahami Boott (88.)

H. Breadalbane.

Beinn Laoigh. Ewing, Wat. B.E.C. Rep., 1912-13, p. 412.

GRAMINEÆ.

Phleum pratense Linn. var. **armatum** Druce (89.)

Alyth. M'T. Cowan, B.E.C. Rep., 1917, p. 55.

Agrostis nigra With. (88.)

H. Breadalbane.

Grassy banks of River Lyon, Fortingal. Marshall, Wat. B.E.C. Rep., 1913-14, p. 464.

A. palustris (alba) var. **major** Gaud. (88.)

Forteviot, L. Earn. Druce, B.E.C. Rep., 1916, p. 508.

Deyeuxia neglecta Kunth. var. **borealis** Benn. (88.)

Discovered by Druce near Killin Pier, Loch Tay, in 1888, but the habitat became destroyed through sawmill operations. Rediscovered by Fraser within a mile of the original station. B.E.C. Rep., 1917, p. 55 and p. 133. See also A. Bennett, Wat. B.E.C. Rep., 1917-18, p. 80.

Apera Spica-venti Beauv. (88.)

Alien, plentiful on a thatched roof at Killin. Fraser, B.E.C. Rep., 1919, p. 688.

Holcus mollis Linn. var. **biaristatus** Parn. (88.)

East of Killin Pier. Fraser, B.E.C. Rep., 1917, p. 134, and 1918, p. 312.

Avena strigosa Schreb. (88.)

Alien, near Birnam. Menzies, Proc. P.S.N.S., vi., 1919, p. x. The var. nigra Marq. near Keltney Burn. Druce, B.E.C. Rep., 1923, p. 221.

Phragmites communis Trin. var. **effusa** A. et G. (88.)

Tayside. Druce, B.E.C. Rep., 1918, p. 408. Var. **nigricens** Gren. et Godr. from Crianlarich. E. S. Marshall, Wat. B.E.C. Rep., 1914-15, p. 574.

Cynosurus echinatus Linn. (88.)

Alien. South Inch, Perth. (Menzies) Barclay, Proc. P.S.N.S., vi., 1917, p. cxlv.

Molinia caerulea var. **subspicata** Fig. (88.)

Banks of Loch Earn. M'T. Cowan, Wat. B.E.C. Rep., 1911-12, p. 367.

Poa nemoralis Linn. var. **Parnelli** Hook et Arn. (88.)

Rocks on north side of An Caisteal (Lomond) at 2300 ft. Marshall, Journ. Bot., 1915, p. 162.

P. Chaixii Vill. (88.)

Alien, established at Kincledie Wood, Dunning. Matthews, Journ. Bot., 1913, p. 196.

P. irrigata Lindman (87, 88.)

H. Forth, Breadalbane.

Ben Lawers, Ben Laoigh, Ben Heasgarnich, and Corrie Ardran (Mid-Perth); and Loch Ard (West Perth). Closely allied to Poa pratensis. For full account see Druce, B.E.C. Rep., 1912, p. 181.

Glyceria declinata Bréb. (88.)

H. Breadalbane.

Muddy ground near Fortingal Hotel and Lawers Inn. E. S. Marshall, Journ. Bot., 1914, p. 168.

Bromus hordeacus var. **leptostachys** Pers. (88.)

Killin. Fraser, B.E.C. Rep., 1922, p. 754. Var. **pseudoracemosus** A. et G., Killin, Fraser, l.c., 1923, p. 223.

Brachypodium pinnatum Beauv. (88.)

H. Breadalbane.

Kenmore. ? native, but passed by Thellung. Druce, B.E.C. Rep., 1925, p. 907.

Lolium perenne var. **sphaerostachys** Mast. (87.)

Aberfoyle. Miss Todd, B.E.C. Rep., 1925, p. 907.

FILICES.

Lastræa dilatata Presl. var. **alpina** (Moore) (88.)

Loch na Chat. Miss Todd, B.E.C. Rep., 1925, p. 908.

EQUISETACEÆ.

Equisetum arvense x limosum (**litorale** Kuhl.) (88.)

South shore of Loch Tummel, Rannoch. E. S. Marshall, Journ. Bot., 1914, p. 168. Apparently the first record for Scotland.

E. variegatum Sch. var. **arenarium** Newm. (88.)

Meall Garbh and by Loch Tummel. Marshall, loc. cit., p. 169.

LYCOPODIACEÆ.

Lycopodium alpinum Linn.

For discussion of the forms of this species and their distribution see Takeda in B.E.C. Rep., 1915, p. 219.

MARSILEACEÆ.

Pilularia globulifera Linn. (88.)

H. Breadalbane.

Loch Tay, Killin. Haggart, Trans. P.S.N.S., vi., 1915, p. 52.

CHARACEÆ.

Chara fragilis Desv. var. **Sturrockii** H. and J. Groves (89.)

In "British Charophyta," by Groves and Bullock-Webster, this variety is regarded as possibly a hybrid with one of the Diplostichae. The plant was found originally by A. Sturrock in Monkmyre.

C. aspera Willd. var. **subinermis** Kuetz. (88.)

Whitemoss Loch. Matthews, Journ. Bot., 1913, p. 196.

Nitella translucens Ag. (87, 88, 89.)

Whitemoss Loch. Matthews, loc. cit., p. 196. Loch Lubnaig. N. J. G. Smith, Trans. P.S.N.S., vii., 1923, p. 268. Recorded from Perth west, mid, and east in "British Charophyta," i., p. 111.

N. spanioclema Gr. et B.-W. (87.)

H. Forth.

Loch Lubnaig. Found by N. J. G. Smith in July, 1921. First record for Britain. See Canon Bullock-Webster, Journ. Bot., 1922, p. 149.

N. flexilis Ag. (87, 88, 89.)

The authors of "British Charophyta," vol. i., pp. 104 and 106, record this and its variety **crassa** Braun. from Perth west, mid, and east.

XXII.—*Note on Batrachospermum moniliforme—* *Additional habitat.*

By G. F. Bates, B.A., B.Sc.

(Read 11th March, 1927.)

This Alga was found by me on 3rd April, 1926, growing in fair abundance in an open drain on the east side of the road from Gleneagles to Glendevon, at a point about two-and-a-half miles from the cross roads at Loaninghead.

XXIII.—*Some Museum Notes.*

By John Ritchie, F.R.A.I.

(Read 11th March, 1927.)

The following may be of interest as records for the County. Among Mammals, the Wild Cat (Felis sylvestris grampia) is reported as both being seen and taken from various districts throughout the County. A water shrew (Crossopus fodiens) was got at Tulloch, and a lesser shrew (Sorex minutus) was brought to the Museum which was found dead in an old nest of a thrush near the mouth of the River Almond.

During the year, among other insects brought to the Museum for identification, was a blood-sucking fly, *Theobaldia annulata*, Schrk., sent in by the Medical Officer for the County, which was causing discomfort, in the nature of Boils, to the residents in the Carse of Gowrie in the early part of this year. It was also very prevalent in the Almondbank district. It is one of our largest mosquitoes, and is to be met with throughout the whole year, as it hibernates indoors during the winter months.

Through the kindness of Mr. J. F. Marshall, of the Hayling Island British Mosquito Control Institute, this short note is illustrated by Plates 33 and 34. These mosquito pests are divided into two great tribes—the Anophalines and the

Culicines. Species of the first named have been recorded from several parts of the County, and it is one of this tribe which is the carrier of Malaria. These two may be roughly divided into three groups, viz.:—1, Domestic, which hibernate during the winter months in houses, and may be destroyed by fumigation; 2, Rural, which breed in woodlands, pools, and boggy ground; 3, those which have their breeding places in salt marshes. The adults of the latter two groups, unlike the first group, die off in the autumn and are carried over the winter months in either the egg or larval stages. All of these groups are to be found within our County area.

Theobaldia annulata, which was the cause of the trouble in the Carse of Gowrie and the Almondbank districts, belong to the first group.

In the eighteenth and the beginning of the nineteenth century, in Statistical Records of Parishes, there is often the reference to Ague or low fever being very common, especially in the valley districts of the County, but as better methods of husbandry were adopted by reclaiming, draining of marshes, and breaking up of waste land, which is the habitat and breeding ground of the Anophaline mosquitoes, these were gradually destroyed and ague disappeared.

Dr. James Ritchie, in "Animal Life in Scotland," 1920, gives a map of the distribution of ague in Scotland, where it is seen that the Tay Valley was one of the worst districts in Scotland for this disease.

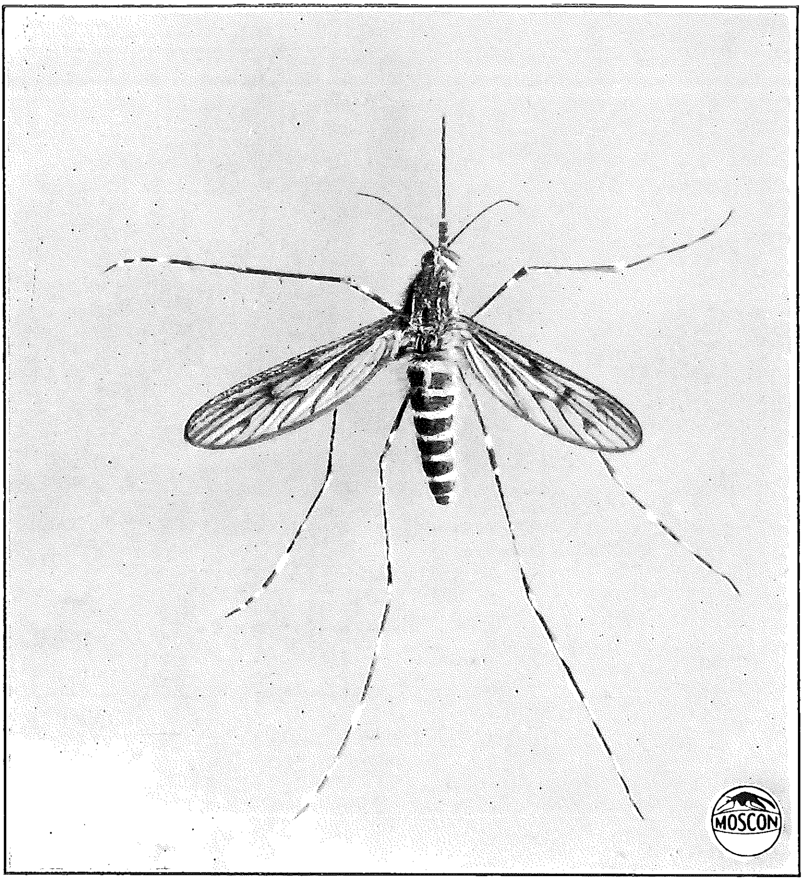
Might I add that any specimens suspected of causing trouble might be sent to the Medical Officer of Health for the County, or to myself at the Museum.

A predacious fly which seemed to be causing annoyance to the residents in the Bridge of Earn district was identified as *Empis livida*, Linne; and in June, Hover Flies of the species *Volucella bombylans* were very common in the Carse of Gowrie.

The Sawflies, *Sirex gigas* and *cyaneus*, during July and August are brought in fairly often, and reports of them are brought in from all over the County.

It may be of interest to record that on two different occasions the Gordius Worm, *Parachordodes violaceous*, was found—one in the Tay near the head of the North Inch in August, and another in June was obtained from a domestic water supply in the city.

When it was possible any animals brought in were examined for the parasitic fauna, both external and internal, of which they might be the hosts. In their identification I have had the assistance of the British Museum staff, notably Mr. Baylis and Dr. Waterston.

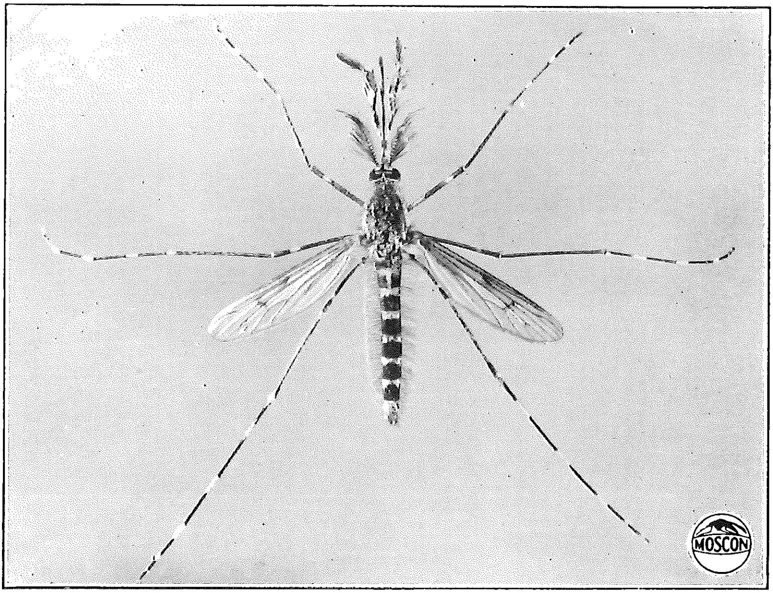


FEMALE OF *THEOBALDIA ANNULATA*. About 4½ times natural size.

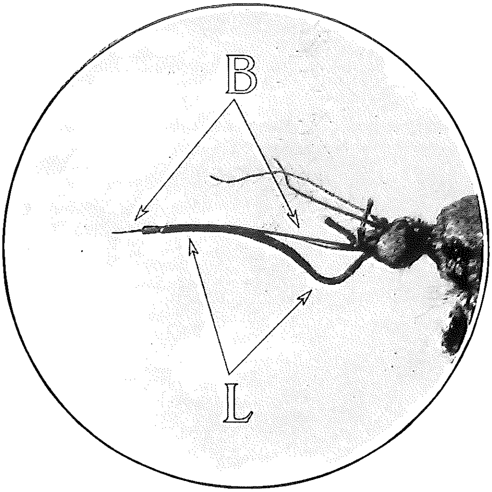
Theobaldia annulata, one of our most common British species, is the largest mosquito in Europe. Being the only English mosquito which has "spotted" wings, *as well as* "ringed" legs, it is very easily recognised. Another of its characteristic features is a prominent white *longitudinal* stripe between the 1st and 2nd transverse "bands" of the abdomen. The wing venation is also distinctive.

The females of *Theobaldia annulata* lay their eggs in "rafts" resembling those of *Culex pipiens,* but composed of a smaller number of eggs; the average number in a *Theobaldia* raft being about 180. The larvae are generally found in very foul water, especially in that which is contaminated by sewage; but they are also common in water butts and garden tanks during the autumn, in company with the larvae of *Culex pipiens.*

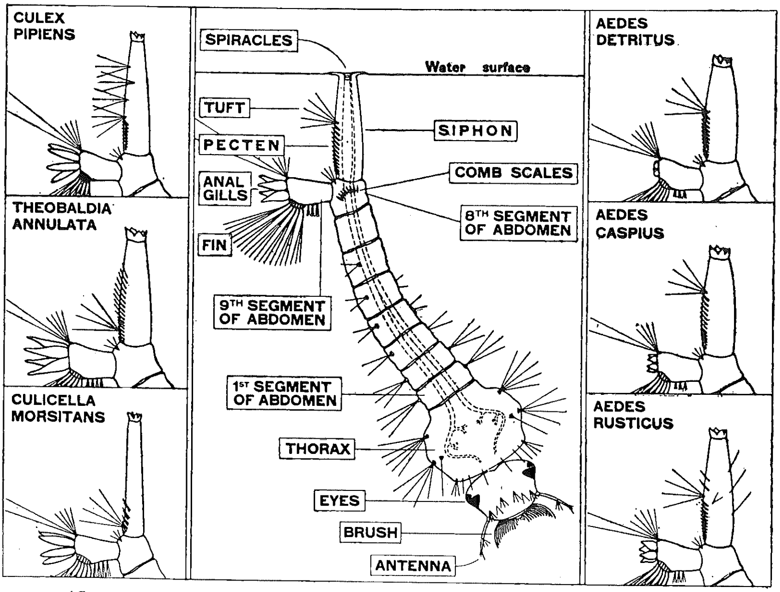
Theobaldia annulata is often referred to as the "large domestic mosquito," because the females hibernate in the cellars, attics, &c., of dwelling houses (together with females of *Culex pipiens*), and often cause considerable annoyance during the winter months, especially in steam-heated residences. Owing possibly to the insanitary conditions under which mosquitoes of this species generally breed, their bites often lead to unpleasant, and even serious, results.



Male of the Culicine mosquito *Theobaldia annulata* (X 4). Note the BUSHY ANTENNAE and the LONG TUFTED PALPS (with the proboscis showing between them), two characteristic features of *male* mosquitoes.



Head of a female Culicine mosquito, showing the proboscis sheath or *labium* (L) partly drawn back in the act of biting, and the "bundle" (B) of six instruments projecting. The bundle (B) comprises (i) two pairs of "lancets," the *maxillae* and the *mandibles;* (ii) the *hypopharynx;* and (iii) the *labrum-epipharynx.* These instruments are respectively employed by the female mosquito for (i) puncturing our skin, (ii) inoculating us with saliva, and (iii) sucking our blood.



(Central Diagram) Larva of a Culicine mosquito, showing the head and thorax *dorsally,* and the eighth abdominal segment *laterally.* Note that the "siphon" (which the larva pushes through the water surface in order to breathe) is situated on the *eighth* segment of the abdomen. The breathing organs *(tracheae)* are indicated by dotted lines. *(Side Diagram).* Siphonal appendages and anal gills of the larvae of six common British mosquitoes. Comb scales omitted. Note that the anal gills of the salt marsh species *(Aedes detritus, Aedes caspius)* are exceptionally short. In *Aedes detritus* the hair tuft is about half-way along the siphon; in *Aedes caspius* it is nearer the extremity.

From the Red Deer (Cervus elaphus) a Bot Fly larvæ from the nasal cavity, and the blood-sucking fly, *Lipoptera cervi*, Linne. This fly is of interest, in that, when it emerges from the pupal stage, both sexes possess wings, which they throw off on attaching themselves to their hosts. It then resembles the ked or sheep tick. It is also to be found on the Roe Deer. On the Roe Deer (Capreolus capræa) the tick, *Ixodes ricinus*, L., is fairly abundant during the shooting season.

From the intestine of the Perthshire Wild Cat I have obtained large numbers of the nematode worm, *Belascaris mystax* (Zed. 1800), and several tapeworms of the species *Taenia taeniaeformis* (Batsch 1786).

On the common Bat (Pipistrellus pipistrellus) the mite *Pteroptus arcuatus* (Koch.) was abundant.

The Lizard, Lacerta vivipara, yielded frcm the intestine the nematode, *Oswaldcruzia filiformis* (Goeze)=*(Strongylus auricularis)*.

From the duodenum of the Quail (Coturnix coturnix coturnix, L.) the scolex of a tapeworm of *Anomotaenia* species.

Three solices of probably the tapeworm, *Davinea brevicollis* (Frol.) were obtained from the intestine of the Cuckoo (Cuculus canorus canorus, L.).

The House Martin (Delichon urbica urbica, L.) harboured the mite, *Dermanysous gallinae* (Redi.), this mite being very common to cage birds and poultry.

Several specimens of the blood-sucking Hippoboscidae flies, *Stenopteryx hirundinis* (Linn.), were found in nests of the Martin in the month of June in the Logiealmond district.

Last spring the Oil Cake on which cattle are fed was undergoing rapid disintegration in a local store. On examination this was found to be caused by having become infested with the mite, *Aleurobius farinae* (Geer.).

XXIV.—*Survey of Methven Loch.*

By JOHN RITCHIE, F.R.A.I.

(Read 11th March, 1927.)

Methven Loch and the mossy bog in its vicinity has, in the past, been a happy hunting ground for many Members of this Society, and records from it have, from time to time, appeared in the pages of the Proceedings and Transactions.

No investigation of a systematic character, however, has been attempted. It was, therefore, proposed by a few Members of the Council of this Society that some attempt might be made towards making an ecological survey of the Loch. Mr. J. Ernest Cox of Methven Castle, on whose estate the Loch is situated, very kindly granted his permission and the use of the boat on the Loch.

The following Members took part in this, viz.:—Messrs. G. F. Bates, James Menzies, William Malloch, James Taylor, Henry Coates, and myself.

The Loch was visited on five occasions between April and September, 1926. On the first two visits the boat was available, but on the other visits inspection round the edge of the Loch only was carried out. A noticeable feature was observed in the colour of the water throughout the year, which had a "pea soup" appearance. Samples taken at various depths showed that a small algæ of a species of the *Anabaena* was the cause.

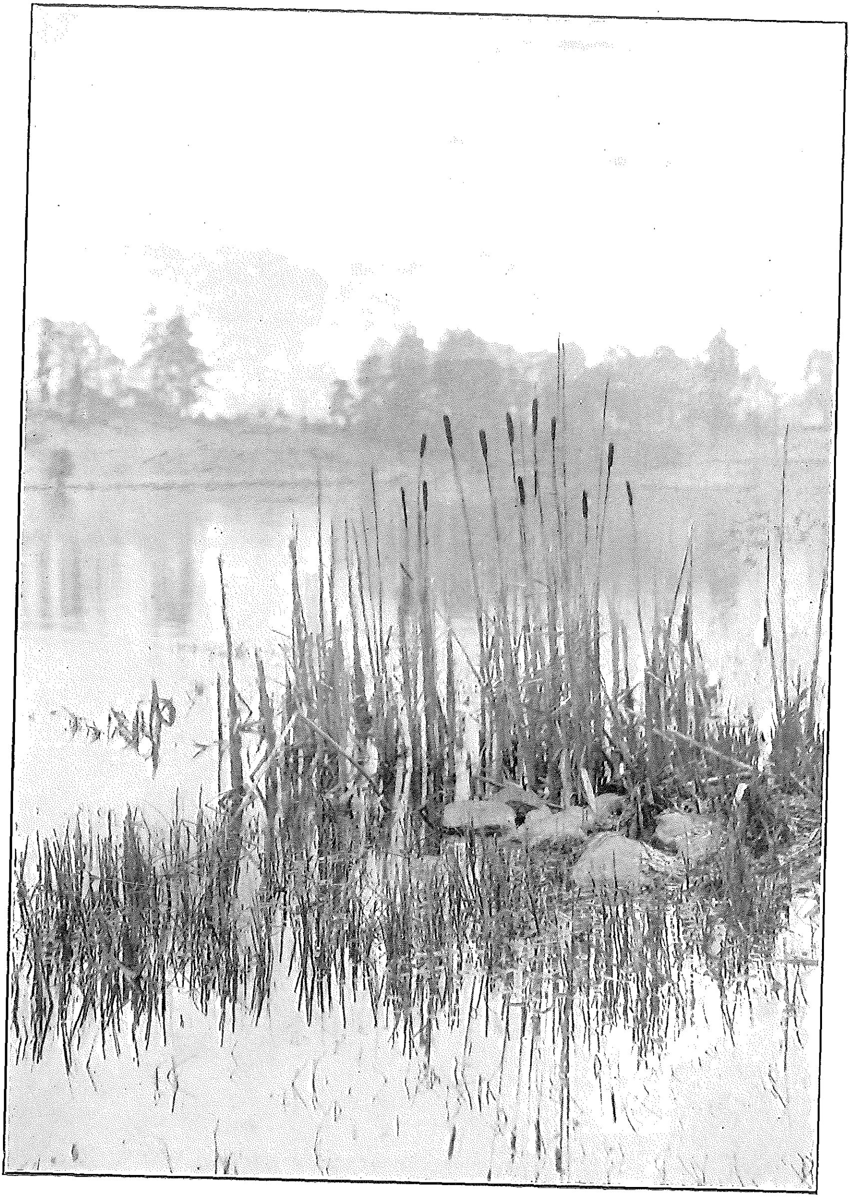
On the visit to the Loch on April 21st a pair of mute swans had nested on the Island, and a large quantity of fish ova was found among the rhizomes of the Bog Bean, which was probably ova of perch. The most notable find was the finding, about three feet below the surface, near the middle of the Loch, the algæ *Batrachospermum favus*, and is probably the first record of it for the county.

In June and August there was found in the mud near the edge specimens of *Nepa cinerea*. So far as I can find, a single specimen, in the nymph stage, of this species was found in 1898 by Messrs. T. M. M'Gregor and G. W. Kirkcaldy, and it is interesting to know that this species still persists in the same locality; the worm *Stylaria lacustris* (L.), and a species of *Chaetogaster*; the following leeches were observed—*Helobdella stagnalis*, *Glossiphonia complanata*, *Herpobdella octoculata*, and *Haemopis sanguisuga*.

In June the molluscs *Planorbis contortus*, *P. nautileus*, and *Pisidium lilljeborgii* were found. In August and Ocotber there were taken *Limnea peregra*, *Physa fontinalis*, and *Hippeutis fontanus* (Lightfoot).

Numerous specimens, botanical and zoological, were taken, but have not yet been gone over.

The experience gained from this preliminary survey, it is hoped, will be able to be carried on, as the environment of the Loch and what has been obtained from it, I think, gives promise of fruitful results from such a survey.



The Island, Methven Loch. [Photo, J. Ritchie.

XXV.—*Occurrence of the Surf-Scoter at Montrose:*

A new record for "Tay."

By Lord Scone, B.A., F.Z.S., M.B.O.U.

(Read 11th March, 1927.)

At the meeting of this Society on 11th March, 1927, I read a short account of the occurrence of the Surf-Scoter, *Oidemia perspicillata* (L.), at Montrose, with the warning that the record could not be definitely accepted until the identification had been proved to be correct.

Miss L. J. Rintoul has now kindly informed me that the bird, a drake, is a genuine Surf-Scoter. It was caught by two youths when boating in Montrose Basin, above the Bridge, on the 1st of March, 1927, and is now in Montrose Museum.

The Surf-Scoter is by far the rarest variety of the three black Sea-ducks of the genus *Oidemia*. Outside the Orkneys where six specimens have been obtained, and a number of others seen, it is a rare straggler to this country, having been got about a dozen times in England and six in Ireland; in Scotland one in the Outer Hebrides and one, possibly two, in the Firth of Forth. I can find no reference to any previous specimen in our area.

Abroad, the Surf-Scoter breeds in northern North America, and probably round the Behring Sea; in winter it visits California and Florida, some reaching the Bermudas and Jamaica.

Wanderers are recorded now and then from the British Isles and N.-W. Europe generally, and as far south as France.

XXVI.—*Recent Additions to the Conchological Collections in the Perthshire Natural History Museum.*

By Henry Coates, F.S.A.Scot.

(Read 11th March, 1927.)

The "Catalogue of the Conchological Collections in the Perthshire Natural History Museum," by the present writer, was read before this Society on 13th February, 1925, and published in the Society's *Transactions*, Vol. VIII., Part II., page 17. It was also re-published in book form by the Property Committee of the Perth Town Council in December, 1925.

Since that date a number of important additions have been made to the Collections, chiefly by exchange with the University College Museum, Dundee. The arrangement of the Conchological Collections in that Museum was entrusted to the writer by the late Professor James Gemmil, F.R.S., a task which he has now completed, after three years' continuous labour. Donations of specimens have also been received from Mr. Walter Gyngell, Scarborough; Mr. Loftus St. George Byne, Exmouth; Mr. C. P. Richards, St. Austel; Mrs. Gubbins, Falmouth; and others. Most of these are members of the Conchological Society of Great Britain and Ireland.

The great majority of the new species are from foreign lands and foreign shores. The reason for this is that the British Collections were already pretty complete, with the exception of species which are rare or difficult to procure. Some of these, however, will no doubt be added from time to time, as opportunities present themselves.

The following is a complete list of the new species up to date, arranged systematically. Many of them are fine specimens, and all are in good condition.

The present list contains the names of 331 new species and varieties. These, with the 1600 species recorded in the previous list, bring up the total number of species in the Museum to 1940.

Eight additional families are now represented for the first time, namely, the Pleurotomariidae, Delphinulidae, Pleurotomidae, Aplustridae, Ringiculidae, Umbrellidae and Gadiniidae, among the Gasteropoda; and Trigoniidae, representing the Pelecypoda.

Phylum **MOLLUSCA** (Soft-bodied Invertebrates).

Class AMPHINEURA (Shell in eight segments).

Order **POLYPLACOPHORA** (Normal multivalves).

Fam. Chitonidae.

1695. Chiton magnifica, *Desh.*

Class GASTEROPODA ("Stomach-footed").

Order **PROSOBRANCHIATA** (Branchiæ in front of the heart).

Section *DOCOGLOSSA* (Radula very long; few teeth in each row).

Fam. Acmæidae.

1696.	Acmæa cummingii.	Vancouver.
1697.	A. fascicularis, *Mke.*	
1699.	A. maculosa.	
1700.	A. pelta, *Esch.*	California.
1701.	A. reticulata.	Victoria.
1767.	A. patina, *Esch.*	Vancouver.
1698.	A. (Lottia) gigantea, *Gray.*	California.
1707.	Scurria mitra, *Esch.*	Central America.

Fam. Patellidae.

1702.	Patella cœrulea, *Linné.*	Australia.
1703.	P. granatina, *Linné.*	South Africa.
1704.	P. oculus, *Born.*	do.
1705.	P. varicosa, *Reeve.*	
1782.	P. gigantea [=mexicana, *Brod and Sow*].	Mexico.
1813.	P. chitonoides, *Reeve.*	Mauritius.
1706.	Helcion pectinata, *Linné.*	South Africa.

Section *RHIPIDOGLOSSA* (Radula long, marginals multiplied).

Fam. Fissurellidae.

1708.	Fissurella crassa, *Lam.*	Australia.
1709.	F. lineata, *Sow.*	
1710.	Emarginula elongata, *Da Costa.*	New South Wales.
1711.	Montfortia imbricata, *A. Ads.*	
1712.	Maerochisma producta, *A. Ads.*	
1713.	M. tasmaniæ, *Sow.*	Tasmania.
1714.	Scutus australis, *Blain.*	New South Wales.

Fam. Pleurotomariidae.

1694.	Scissurella crispata, *Flem* .	(*British*, 281). Holm of Stromsay, Shetland. 8 fms.

Fam. Haliotidae.

1715.	Haliotis cracherodi, *Leach.*	California.
1716.	H. glabra, *Chem.*	Singapore.
1717.	H. iris, *Gmel.*	New Zealand.
1718.	H. lauta, *Reeve.*	
1719.	H. rufescens, *Swain.*	California.

Fam. Stomatellidae.

1720.	Gena nigra, *Quoy.*	South Australia.
1721.	G. strigosa, *A. Ads.*	do.

Fam. Trochidae.

1722.	Trochus erythraeus, *Brocc.*	Aden.
1769.	T. argentea-nidens, *Lischka.*	Japan.
1768.	T. pyramis, *Born.*	Singapore.
1723.	Chlorostoma pellisserpentis, *Wood.*	Pacific Islands.

1724.	C. punctulatum, *Mart.*	New Zealand.
1770.	C. carpenteri, *Dunkr.*	Japan.
1725.	Gibbula musiva, *Gould.*	South Africa.
1726.	Umbonium giganteum, *Less.*	China.
1728.	U. costatum, *Val.*	Eastern Seas.
1727.	Elenchus lineatus, *Lam.*	Australia.

Fam. Delphinulidae.

1729.	Delpinula tyria, *Reeve*	Red Sea.
1771.	D. lacinata, *Lam.*	Singapore.

Fam. Turbinidae.

1730.	Turbo ticaonicus, *Reeve.*	Singapore.
1731.	T. crassus, *Wood.*	
1732.	T. (Ocana) Natalensis, *Reeve.*	Port Shepstone, Natal.
1777.	Astralium olfersi, *Trosc.*	Pacific Islands.
1659.	Phasianella venosa, *Reeve.*	

Fam Neritidae.

1735.	Navicella variabilis, *Recl.*	Solomon Islands.

Fam. Helicinidae.

1816.	Helicina (Trochatella) regina, *Morelet.*	Cuba.

Section *PTENOGLOSSA* (Radula with teeth similar throughout; outermost largest).

Fam. Scalidae.

1734.	Scala caledonica, *Boury.*	Wednesday Island. (Chall. Exped.)

Section *TAENIOGLOSSA* (Radula with formula 2. 1. 1. 1. 2.).

Fam. Naticidae.

1772.	Natica glauca, *Humb.*	California.
1817.	N. pulicaris, *Phil.*	
589.	N. fulminea, *Linné*, var. punctata, *Swains.*	Algiers.
1736.	Amauropsis [=Natica] islandicus, *Gmel.*	(*British*, 389). Firth of Forth.

Fam. Trichotropidae.

1878.	Trichotropis cancellata, *Hinds.*	Pugent Sound.

Fam. Xenophoridae.

1737.	Xenophora corrugata, *Reeve.*	China Sea.
1738.	X. indica, *Reeve.*	Indian Ocean.
1764.	X. pallidula, *Reeve.*	Java.

Fam. Capulidae.

1739.	Crucibulum extinctorum, *Sow.*	Singapore.
1747.	Trochita novaezelandia.	New South Wales.

Fam. Hipponycidae.

1740.	Mitrularia dillwynyii, *Gray.*	West Indies.
1746.	M. tectusinense, *Lam.*	do.

Fam. Solariidae.

1741.	Solarium trochleare, *Hinds.*	Indian Ocean.
1742.	S, perdix, *Hinds.*	Java.
1743.	S. laevigatum, *Lam.*	Indian Ocean.
1744.	Torninia variegata, *Gmel.*	do.
1745.	Philippia lutea, *Lam.*	New South Wales.

Fam. Littorinidae.

1748.	Risella melanostoma, *Gmel.*	Port Jackson, New South Wales.
1867.	Tectarius bullatus, *Mart.*	Philippine Islands.

Fam. Cyclophoridae.

1750.	Cyclophorus menkeanus, *Pfr.*	Ceylon.
1758.	C. involvulus, *Müll.*	do.
1751.	Theobaldius annulatus, *Tros.*	do.
1752.	Pupina nunezii, *Sow.*	Philippine Islands.
1756.	Tortulosa [=Cataulus] decora, *Bens.*	Ceylon.
1760.	Aulopoma itieri, *Guerin.*	do.

Fam. Cyclostomatidae.

1753.	Cyclostoma zanguebarica, *Petit.*	Mozambique.
1757.	C. bicarinata, *Sow.*	Madagascar.
1754.	Choanopoma corrugatum.	Jamaica.
1755.	C. fimbriatum, *Sow.*	do.
1759.	Tudora javana, *Ad.*	do.

Fam. Viviparidae.

1762.	Vivipara angularis, *Müll.*	India.
1763.	V. (Melantho) decisa, *Say.*	Indiana, U.S.A.

Fam. Ampullariidae.

1761.	Ampullaria virens, *Linné.*	East Indies.

Fam. Cerithiidae.

1765.	Vertagus lineatus, *Brug.*	Loyalty Islands.
1831.	Planaxis planicostatus, *Sow.*	Panama.

Fam. Melaniidae.

656.	Melania tuberculata, *Müll*, var. judaica.	Sea of Galilee, Palestine.
1811.	M. acanthica, *Dohrn*.	Vate, New Hebrides.
1812.	M. nassa, *Woodw*.	Lake Tanganyika, Central Africa.
1766.	Paludomus neritoides, *Reeve*.	Ceylon.
1773.	P. loricata, *Reeve*.	do.
1786.	Hemisinus lineolatus, *Gray*.	Jamaica.

Fam. Pleuroceridae.

1774.	Pleurocera filum, *Lea*.	Kentucky, U.S.A.
1775.	Anculosa praerosa, *Say*.	Alabama, U.S.A.

Fam. Turritellidae.

694.	Turritella communis, *Lam*.	
	var. gracilis.	Firth of Forth.
	mons. scalaris.	do.
1776.	T. bicolor, *Reeve*.	

Fam. Strombidae.

1778.	Strombus gibberulus, *Linné*, var. zebra.	Indian Ocean.
1779.	S. urceus, *Linné*, var. chrysostomus, *Reeve*.	Singapore.
1785.	S. marginatus, *Linné*.	Philippine Islands.
1780.	Pterocera aurantia, *Lam*.	Indian Ocean.
1781.	P. rugosa, *Lam*.	do.
1814.	P. millepeda, *Linné*.	do.
1679.	P. elongata, *Swain*.	do.
1784.	Rostellaria curvirostris, *Lam*.	Red Sea.
1799.	Rimella cancellata, *Lam*.	Indian Ocean.

Fam. Cypræidae.

142.	Cypræa cruenta, *Gmel*, var. coloba, *Melville.*	Indian Ocean.
1789.	C. cylindrica, *Born.*	North West Australia.
1793.	C. felina, *Gmel.*	South Sea Islands.
1808.	C. irrorata, *Sol.*	Society Islands.
378.	C. (Aricia) caput-serpentis, *Linné.* Banded variety.	Indian Ocean.
148.	C. (A.) moneta, *Linné.* Variety with green bands.	New Hebrides.
139.	C. (A.) arabica, *Linné.* Pale variety.	Mauritius.
134.	C. (A.) mauritiana, *Linné,* var. calxaquina, *Melv.*	do.
1787.	C. (A.) stercoraria, *Linné.*	West Africa.
	var. rattus, *Lam.*	do.
1788.	C. (A.) scotti, *Gask.*	Western Australia.
1790.	C. (A.) scurra, *Linné.*	Indian Ocean.
1680.	C. (Luponia) annettae, Dall. [=Sowerbyi, *Kien.*]	Gulf of California.
1689.	C. (L.) pallida, *Gray.*	Persian Gulf.
133.	C. (L.) tigris, *Linné.* Pale variety.	Indian Ocean.
151.	C. (L.) onyx, *Linné,* var. adusta, *Chem.*	California.
	var. succincta.	do.
1791.	C. (L.) stolida, *Linné.*	Fiji Islands.
1809.	C. (L.) sanguinolenta, *Gmel.*	Gambia.
391.	C. (L.) caurica, *Linné,* var. oblongata, *Melv.*	Persian Gulf.
152.	C. (L.) erosa, *Linné,* var. nebrites, *Melv.*	Borneo.
1795.	Trivia aperta, *Swains.*	South Africa.
1796.	T. australis, *Lam.*	Victoria, Australia.
1797.	T. radians, *Lam.*	Guaymas, Gulf of California.
1810.	T. insecta, *Migh.*	Sandwich Islands.
1818.	T. pulex, *Gray.*	Azores.
1798.	Pustularia cicercula, *Linné,* var. globulosa, *Linné.*	New Caledonia.
1681.	Calpurnus verrucosa, *Linné.*	Fiji Islands.
1794.	Cypræovula capensis, *Gray.*	South Africa.

Fam. Doliidae.

330.	Dolium deshayesi, *Reeve.*	
1800.	D. olearium, *Brug.*	Indian Ocean.
77.	D. maculatum, *Lam*, var. album.	North Australia.
1801.	Pyrula [=Ficus] ventricosa, *Sow.* [=decussata, *Wood.*]	San Blas, Mexico.
1802.	P. desumieri, *Val.*	Philippine Islands.

Fam. Cassididae.

720.	Cassis achatina, *Lam.*	South Africa.
1803.	C. torquata, *Reeve.*	Loyalty Islands.
1807.	C. inflata, *Shaw.*	Mediterranean.
1792.	C. (Phalium) coronulata, *Sow.*	Philippine Islands.
1804.	Cassidaria [=Morio] echinophora, *Linné.*	Mediterranean.
1805.	Onicia [=Morum] cancellata, *Sow.*	China.

Fam. Tritonidae.

1819.	Triton (Simplum) chlorostoma, *Lam.*	Cape Verde Islands.
1820.	T. (Cabestana) spengleri, *Ch.*	South Australia.
1888.	T. (C.) cutaceum, *Linné.*	Pugent Sound.
1821.	T. (Gutturnium) pyrum, *Linné.*	Loyalty Islands.
1806.	Distorsio [=Persona] cancellinus, *Desh.*	China.
1830.	D. decipiens, *Reeve.*	Philippine Islands.
1822.	Bursa [Ranella] albivaricosa, *Reeve.*	Japan.
1823.	B. tuberculata, *Brod.*	Bombay.

Section *RACHIGLOSSA* (Radula with marginal teeth. Teeth strongly cusped).

Fam. Muricidae.

1832.	Murexternispina, *Lam.*	Suez.
1833.	M. (Chicoreus) calcitrapa, *Lam.*	Red Sea.
1834.	M. (C.) maurus, *Brod.*	

1835.	M. (C.) spectrum, *Reeve.*	
1836.	M. (C.) affinis, *Reeve.*	
1837.	M. (C.) permaestus, *Hedley.*	North Australia.
1838.	M. (Muricantha) spinosus, *A. Ad.*	Tranquebar.
1839.	M. (Ceratostoma) nuttalli, *Conr.*	California.
1840.	M. (Pteronotus) pinnatus, *Wood.*	China.
1841.	Purpura floridana, *Conr.*	Florida.
1842.	P. rudolphi, *Lam.*	South Africa.
1843.	P. neritoidea, *Desh.*	Cape Verde Islands.
1863.	P. haustrum, *Mart.*	New Zealand.
1844.	P. (Polytropa) textiliosa, *Lam.*	Portland, Victoria.
1845.	P. (P.) succinta, *Mart.*	do.
1846.	P. (Thalessa) mancinella, *Linné.*	New Caledonia.
1847.	P. (Cuma) kiosquiformis, *Ducl.*	Java.
1824.	Ricinula digitata, *Lam.*	Ancitium.
760.	R. ricinus, *Linné*, var. albolabris, *Lam.*	Loyalty Islands.
1848.	Trophon gaversianus, *Pallas.*	Straits of Magellan.
1850.	Acanthina [=Monoceros] imbricata, *Lam.*	West Coast of South America.
1851.	A. brevidentata, *Gray.*	do.
1852.	A. crassilabrum, *Lam.*	do.
	var. citrina, *Sow.*	do.
1853.	Agnewa [=Adamsia] tritoniformis, *Blainv.* [=typica. *Dunkr.*]	

Fam. Coralliophilidae.

1849.	Coralliophila violacca, *Chem.* [=neritoidea, *Lam.*]	Red Sea.

Fam. Columbellidae.

775.	Columbella fulgurans, *Lam.*, var. punctata, *Lam.*	Thursday Island, Torres Straits.
1855.	C. strombiformis, *Lam.*	Gulf of California.
1856.	C. major, *Sow.*	Mexico.

1690.	C. (Mitrella) alizonæ, *Melv. and Stand.*	Persian Gulf.
1682.	Engina lincata, *Reeve.*	Loyalty Islands.

Fam. Nassidae.

1825.	Nassa (Alectrion) papillosa, *Linné.*	Mauritius.
1887.	N. (Hebra) nodifera, *Powis.*	Lifu.
1870.	Bullia belangeri, *Kiener.*	Aden.

Fam. Buccinidae.

818.	Bucelnum undatum, *Linné*, var. zetlandicum, *Forbes.*	(*British*, 492). Firth of Forth.
1857.	Tritonofusus [=Fusus=Sipho] jeffreysianus, *Fischer.*	(*do.* 505). Bristol Channel.
1858.	Euthria viridula, *Dunkr.*	Japan.
1859.	Macron lividus, *A. Ads.*	California.
1860.	Phos senticosus, *Linné.*	Singapore.
1861.	Hindsia [=Nassaria] nivea, *Gmel.*	do.
1869.	Tritonidea (Cantharus) fumosa, *Dillw.*	New Guinea.
692.	Volu tharpa perryi, *Jay.*	
1826.	Eburna japonica, *Sow.*	Japan.
1862.	E. areolata, *Lam.*	do.

Fam. Turbinellidae.

1688.	Fulgur [=Busycon] canaliculatum, *Linné.*	Florida.
1815.	Melongena (Hemifusus) ternatanus, *Gmel.*	Singapore.
1866.	M. (H.) morio, *Linné.*	West Indies.
1865.	Vasum [=Cynodonta] capitellum, *Linné.*	
1868.	V. muricatum, *Born.*	

Fam. Fasciolariidae.

1871.	Fasciolaria inernis, *Jonas*.	
1854.	Latirus brevicaudatus, *Reeve*.	West Coast of South America.
1872.	L. lignarius, *Linné*.	Mediterranean.
1873.	L. (Plicatella) carinifera, *Lam*.	Viti Islands.
1874.	L. (Leucozonia) cinguliferus, *Lam*.	West Indies.
1875.	Fusus alternatus, *Phil*.	
1876.	F. australis, *Quoy*.	South Australia.
1877.	F. Polygonoides, *Lam*.	Suez.

Fam. Mitridae.

1879.	Mitra papalis, *Lam*.	Philippine Islands.
1880.	M. (Chrysame) ferruginea, *Lam*.	Mauritius.
1881.	M. (Turricula) cinctella, *Lam*.	Ceylon.
1882.	M. (T.) melongena, *Lam*.	Singapore.
1883.	M. (T.) costellaris, *Lam*.	do.
1884.	M. (T.) caffra, *Lam*.	Philippine Islands.
1885.	M. (T.) pullata, *Reeve*.	Singapore.
1889.	M. (Callithea) exasperata, *Reeve*.	Samoa.
1891.	M. (Chrysame) adusta, *Lam*.	Philippine Islands.
1892.	M. (Scrabicula) lifouana, *Crosse*.	Lifu.

Fam. Volutidae.

1886.	Voluta (Lyria) delessertiana, *Petit*.	Madagascar.
1898.	V. (L.) mitraeformis, *Lam*.	Australia.
1894.	V. (Alcithoe) pacifica, *Sol*.	do.
1895.	V. (Harpula) lapponica, *Linné*.	Ceylon.
1896.	V. (Cymbiola) rückeri, *Crosse*.	West Australia.

1897.	V. (C.) nivosa, *Lam.*	West Australia.
1899.	V. (Scaphella) zebra, *Lam.*	do.
1900.	Cymbium cymbium, *Linné.*	
1893.	Volumitra melania, *Lam.*	New South Wales.

Fam. Olividae.

1691.	Oliva incrassata, *Sol.*	Panama.
1905.	O. australis, *Duclos.*	Australia.
1906.	O. caroliniana, *Duclos.*	Carolina.
1907.	O. conoidalis.	
1908.	O. lepida, *Duclos.*	Java.
1909.	O. dactyliola, *Duclos.*	
1910.	O. fumosa, *Mart.*	
1911.	O. fuscata, *Mart.*	Guaymas, Gulf of California.
1912.	O. spicata, *Bolt.*, var. melchersi, *Menke.*	
1913.	O. pica, *Lam.*	Philippine Islands.
1914.	O. tigrina, *Lam.*, var. holoserica, *Mart.*	New Caledonia.
1915.	O. mustellina, *Lam.*	Panama.
41.	O. erythrostoma, *Lam.*, var. tremulina, *Lam.*	New Hebrides.
	var. nobilis, *Reeve.*	do.
	var. pallida.	do.
48.	O. peruviana, *Lam.*, var. zebra.	California.
289.	O. ispidula, *Linné*, var. fasciata.	Philippine Islands.
290.	O. inflata, *Lam.*, var. faleagrina.	Red Sea.
	var. undata.	do.
298.	O. reticularie, *Lam.*, var. globosa.	Florida.
	var. pallida.	do.
	var. nivosa, *Marr.*	Mexico.
287.	O. (Porphyria) irisans, *Lam.* Brown variety.	Philippine Islands.
1683.	Olivella tergina, *Duclos.*	West Indies.

1684.	O. cuneata, *Marr.*	West Indies.
1828.	Ancilla (Baryspira) obtusa, *Sow.*	Port Elizabeth.
1917.	A. (Eburna) glabrata, *Linné.*	West Indies.
1916.	Olivancillaria brasiliana, *Lam.*	Brazil.

Fam. Marginellidae.

1827.	Marginella (Persicula) persicula, *Linné.*	South Africa.
1901.	M. (Cryptospira) quinqueplicata, *Lam.*	Java.
1902.	M. (C.) longivaricosa, *Lam.*	West Indies.
1903.	M. (Glabella) muscaria, *Lam.*	do.
1904.	M. (Prunum) prunum, *Gmel.*	Brazil.

Section *TOXOGLOSSA* (Radula with normal formula, 1. 0. 1. Teeth large. Aesophagus with large poison gland).

Fam. Terebridae.

1918.	Terebra duplicata, *Linné.*	Mauritius.
1919.	T. oculata, *Lam.*	Indian Ocean.
1920.	T. senegalensis, *Lam.*	River Gambia, West Africa.
1921.	T. variegata, *Gray.*	Guaymas, Gulf of California.
1924.	T. babylonica, *Lam.*	Tahiti.
1925.	T. coerulescens, *Lam.*	Solomon Islands.

Fam. Conidae.

883.	Conus (Coronaxis) aristophanes, *Ducl.*	Suez.
888.	C. (C.) miliaris, *Hwass.*	Loyalty Islands.
1929.	C. (Stephanoconus) balteatus, *Sow.*	Indo-Pacific Ocean.
1930.	C. (Leptoconus) regularis, *Sow.*	Guaymas, Gulf of California.
1931.	C. (Rhizoconus) interruptus, *Brod.*, var. mahogani, *Reeve.*	Panama.

1932.	C. (R.) magus, *Linné.*	Singapore.
1933.	C. (Chelyconus) tinianus, *Hwass.*, and var. rosacea, *Ch.*	Cape of Good Hope.
1944.	C. (C.) epistomus, *Reeve.*	Mauritius.
1934.	C. (Cylinder) aulicus, *Linné.*	Ceylon.
1942.	C. (C.) omaria, *Brug.*	Andaman Islands.
1943.	C. (Dendroconus) betulinus, *Linné.*	Ceylon.
1890.	Pusionella rapulum, *Reeve.*	India.

Fam. Pleurotomidae.

1864.	Mangilia interrupta, *Reeve.*, var. bella, *Pease.*	Lifu.
1923.	M. [=Pleurotoma] (Bellardiella [=Defrancia]) gracilis *(Mont.)*	*(British*, 548).
1926.	Turris [=Pleurotoma] Kraussi, *Smith.*	Algoa Bay, South Africa.
1927.	T. rosaria, *Reeve.*	do. do.

Fam. Cancellariidae.

1922.	Cancellaria reticulata, *Linné.*	West Indies.

Order **OPISTHOBRANCHIATA.** (Breathing organs, when present, behind the heart.)

Sub-order *TECTIBRANCHIATA.* (Right breathing organ more or less concealed by the mantle.)

Fam. Bullidae.

1942.	Bulla gouldiana, *Pils.*	California.

Fam. Aplustridae.

1935.	Aplustrum amplustre, *Linné.*	Philippine Islands.
1936.	Bullina scabra, *Gmel.* [=ziczac, *Muhlf.*]	New South Wales.

Fam. Ringiculidae.

1941.	Ringicula australis, *Hinds.*	Lifu.

Fam. Aplysiidae.

1937.	Dolabella gigas, *Rang.*	Mauritius.
1938.	D. scapula, *Martyn.*	do.

Fam. Umbrellidae.

1939.	Umbrella [=Umbraculum] indica, *Lam.*	Mauritius.
1940.	U. mediterranea, *Lam.*	Mediterranean.

Fam. Gadiniidae.

1749.	Gadinia peruviana, *Sow.*	Peru.

Sub-order *PTEROPODA* ("Wing-footed." Pelagic Mollusca).

Section *THECOSOMATA* (Shell always present. Fins connected by a lobe).

Fam. Cavoliniidae.

1928.	Cavolina [=Hyalæa] longirostris, *Less.*	Atlantic [Pelagic].

Order **PULMONATA** ("Lung-breathers." Mostly Inoperculate Land and Freshwater Mollusca).

Fam. Vitrinidae.

1687.	Vitrina major, *Fér.*	*(Brit. L.* and *F.-W.* nov. sp.*)*. Burnham Beeches, Bucks. [Prof. A. E. Boycott, F.R.S., Apr., 1926.]

Fam. Zonitidae.

1050.	Polita draparnaudi, (Beck.) F. albina, *Moq.-Tand.*	*(Brit. L.* and *F.-W.*, 18*)*. Clifton, Bristol.

Fam. Helicidae.

1692.	Polygyra tridentata, *Say.*	Delaware, U.S.A.
1733.	Corilla erronea, *Pfr.*	Ceylon.
1693.	Helix (Eremina) desertorum, *Forsk.*	Egypt.

Class PELECYPODA ("Axe-footed." Headless Mollusks, with bivalve shells) [=Lamellibranchiata ("Plate-gilled" Mollusks)].

Fam. Arcadae.

1656.	Arca (Barbatia) barbata, *Linné.*	Singapore.
1657.	A. (Anomalocardia) granosa, *Linné.*	do.

Fam. Trigonidae.

1658.	Trigonia pectinata, *Lam.* [=margaritacea, *Lam.*]	Victoria, Australia.

Fam. Pectinidae.

1677.	Pecten ventricosa, *Sow.*	St. Elena, West Columbia.
1678.	P. sulcatus, *Müller.*	Mediteranean.
1661.	P. radula, *Linné.*	Singapore.
1662.	P. (Chlamys) asperrimus, *Lam.*	Bass Strait. [Chall. Exped.]

Fam. Spondylidae.

1663.	Spondylus princeps, *Brod.*	West Columbia.
1664.	S. lamarckii, *Chem.*	Philippine Islands.
1665.	S. plurispinosus, *Reeve.*	do.
1666.	S. radiatus.	

Fam. Carditidae.

1685.	Cardita sulcata, *Lam.*	Algeciras, Spain.

Fam. Tellinidae.

1660.	Tellina rugosa, *Born.*	Cannes.

Fam. Veneridae.

1668.	Venus mercenaria, *Linné.*	United States of America.
1651.	Tapes litteratus, *Linné.*	West Australia.

1654. Circe gibba, *Lam.*	Indian Ocean.
1655. C. scripta, *Linné.*	Philippine Islands.
1653. Cyclina pectunculus, *Römer.*	Japan.

Fam. Cardiidae.

1669. Cardium isocardia, *Linné.*	Antilles.
1670. C. angulatum, *Lam.*	
1671. C. leucostoma, *Born.*	East Indies.
1672. C. variegatum, *Sow.*	Philippine Islands.
1673. C. multispinosum, *Reeve.*	
1674. C. corbis, *Mart.*	Alaska.

Fam. Garidae [=Psammobiidae].

1651. Soletellina biradiata, *Sow.*	Victoria, Australia.

Fam. Saxicavidae.

1686. Panopea australis, *Sow.*	Australia.

Fam. Cuspidariidae.

1829. Cuspidaria [=Neæra] rostrata, *Speng.*	Yokohama, Japan.

XXVII.—*Notes on the History of the Potato in Britain.*

Presidential Address.

By JAMES MENZIES.

(Read December 9, 1927.)

The Potato, **Solanum tuberosum,** owes its value as a food, and its utility in other respects, to the peculiar habit of the plant in the production of under-ground stems, which gradually swell out at the free end into tubers, rich in starch, and studded with eyes, or buds, by which the plant can be propagated for an indefinite period. The potato is a well-known native of South America, and there seems to be satisfactory evidence that the plant was cultivated by the Incas long before the conquest of Peru by the Spaniards. By the Spaniards it was introduced into Spain about the beginning of the sixteenth century, and from there it passed into Italy, Burgundy, and the Netherlands, but only to be cultivated as a garden curiosity. The early history of the potato is confused by the circumstance that it received the same name, "Batatis," as the sweet potato, **Ipomea batatis,** which had previously been in wide cultivation in Europe, and it is this plant which is meant by English writers down to the middle of the seventeenth century. It is generally accepted that the first certain record of the potato in England is that of John Gerard in his famous "Herbal." Gerard was born in Cheshire in 1545, and studied medicine as an apprentice of the Barber Surgeons Company, and was elected a member of that company in 1595. He was an accomplished herbalist, and was superintendent of the gardens of Lord Burghley, in the Strand, and also at Theobalds, in Hertfordshire. In 1596 he published a list of the plants in those gardens, and this was the first catalogue of plants of any garden, public or private. Again, in 1597, Gerard published his famous "Herbal." This work is not so well known in Scotland, and, indeed, does not make the same appeal, in many respects, as it does to English people. The "Herbal" contained more than 1800 woodcuts of plants; amongst which there is a figure of the potato, of which Gerard states that he received the roots from Virginia, and planted them in his garden as a curiosity, under the name of **Batatis Virginanum.** The merits of the potato were still far from being appreciated, and, more than twenty years later, when the "Complete Gardener" of Louden and Wise was published in London, the potato was not even mentioned.

The Irish were the first people in Europe to recognise the merits of the potato, and its introduction into that country is often ascribed to Sir Walter Raleigh. This would make its introduction in 1548, or, after Sir Walter's last voyage, eleven years later, in 1559. Be this as it may, the cultivation of the potato must have made great strides in the Island during the first half of the seventeenth century, and its successful culture there attracted the attention of the Royal Society in 1663, who took steps to popularise the plant in England, but it was not until almost the end of the seventeenth century, when the potato was introduced into Lancashire, that its culture became general, and spread all over England, becoming an important field crop. It is worthy of note that when Pennant, on his way to begin his tour of Scotland in 1772, speaking of Lancashire, through which he was passing, says, "I must not omit that 30-40,000 bushells of potatoes are annually exported into the Mediterranean from the rich fields around Warrington, at the medium price of 14 pense a bushell." "And," he adds, "this is the root that honest Gerard speaks of as a meat of pleasure, roasted in the embers, or boiled and eaten with vinegar, oil, and pepper, or dressed some other way by the hands of a skilful cook."

By whom the potato was first introduced into Scotland is not known. The evidence points to a number of independent introductions, the source of which was Ireland. Chambers, in his "Domestic Annals of Scotland," says, "The potatoe was first heard of in Scotland in 1701, when the Duchess of Buccleuch's household book mentions a peck of the esculent bought in Edinburgh, and costing 2/6 a peck." In Lord Belhaven's "Advice to the Farmers of East Lothian," he recommends the planting of potatoes and turnips, but only for domestic use. "Potatoes," he says, "never fail, and, when once planted, require little more labour." This was in 1723. Hume Brown, in his "History of Scotland," states that in Mid Lothian Cockburn of Ormiston began the cultivation of potatoes in his garden in 1726, and others followed his example. In the Transactions of Galloway and Dumfries Natural History and Antiquarian Society, there occurs an interesting note, not only on the introduction of the potato, but also for the light it sheds on the economic condition of the people of Scotland in the eighteenth century. The writer, quoting from the reminiscences of John Maxwell of Munches (born 1720), a pioneer of agriculture in Galloway, where he states, "Potatoes were first introduced into the Stewartry by William Hyland in 1725 from Ireland, and he, Hyland, carried them on horses' backs to Edinburgh, and sold them in pounds and ounces. And further, during these years and times when potatoes were not generally cultivated, there was a great scarcity, bordering on famine, in the Stewartry of Kircudbright and County of Dumfries. As there was not enough victuals produced as was necessary foı the inhabitants, the chief part of which was brought from the sand-beds of Esk on tumbling carts, and when the water was high with spates, and there being no bridges, so that the carts could not come, I have seen the tradesmen's wives crying in the streets of Dumfries, because there was none to get."

A writer in the "New Statistical Account of Scotland" makes a strong claim that the first potatoes grown in Scotland were at Tulloch. He writes, "Tulloch, which is about 2 miles from Perth, is memorable as being the first bleaching establishment in Scotland. It was established about the beginning of the eighteenth century by a gentleman of the name of Christie, from Ireland. And it may be here mentioned that the first potatoes grown in Scotland was at this place, from seed brought from Ireland by Mr. Christie."

According to the Duke of Argyll, in "Scotland As It Was and Is," the potato was introduced by Macdonald of Clanranald into South Uist in 1743, but the Highlanders resisted its use for some years, and it was not until 1752 that it reached the neighbouring island of Barra. Yet, in another ten years, the potato had come to support the whole population for at least a quarter of the year. On the mainland, the progress of potato culture in the North was even slower, and it was only in 1766 that the first boll of potatoes was planted in Sutherlandshire.

The cultivation of the potato in Scotland was at first by the "lazy bed" method, which is still in vogue in Ireland, on low-lying boggy ground and where no better method could be adopted. But in 1739 the experiment of growing the potato in fields was tried at Kilsyth, in Stirlingshire, by a gentleman named Robert Graham, of Tamrower. An account of this event is given in the "Old Statistical Account of Scotland," from which the following is extracted, "If the name of any one deserves to be handed down to succeeding ages with honour and gratitude, it is that of Robert Graham, who set vigorously to work in the cultivation of potatoes in the fields. Before this period, there was a vulgar prejudice that they could only be raised to advantage in gardens. To show the absurdity of this opinion, he planted half an acre at Nelston, where he resided. This excited the attention of the neighbourhood, and, the report spreading, people of all denominations, and some noblemen of high rank, amongst which was the unfortunate Earl of Perth, came to view the plantation, and, had they known the amazing benefit that was to accrue to the nation, would have hailed the auspicious event, and erected a monument to him on the spot; and, nothwithstanding the ignorant ridicule to which his first experiment exposed him, persevered and, in order to spread the blessing far and wide, he rented lands in the vicinty of Renfrew. Perth, Dundee, Edinburgh, and Glasgow, for the cultivation of potatoes, and received premiums on their cultivation." The concluding sentence in this extract, as to Graham having received premiums on the cultivation of potatoes, is at least very doubtful. The field culture of the potato was introduced into

Midlothian in 1746, by a man named Prentice, described as a strolling gardener, who had spent some time in England. Others, seeing it profitable, followed his example. So that, before 1760, the root was generally raised in the fields as at present.

The "Old Statistical Account of Scotland" was published in 1796, and the accounts of the various parishes show that the potato was then cultivated all over the country, and in Midlothian the farmers had already the difficulty of over-production. This is very clearly set forth in an article in the "Scots Magazine" of 1796, dealing with the agriculture of Midlothian. In this the writer states that, not long after farmers began planting them in the fields, they were raised in such quantities that they became a drug in the market; which discouraged raising them for some time, until such time as, the price getting up again, led many to plant more, which again led to the same consequences. In this periodical manner they have, every four or five years, been a crop difficult to dispose of, and little to be got for them. In the face of this, it is highly interesting to find that in this same year, 1796, there was a motion in Parliament to the following effect:—Sir John Sinclair moved that "on that day sennight the House should resolve itself into a Committee of the whole House to consider the propriety of granting a bounty on raising potatoes, which was agreed to." I have been unable to discover the fate of this resolution, but it seems to dispose of the statement that Graham, who first cultivated the potato in fields, received a premium on their cultivation. But the authorities of that day were bent on the stimulation of potato culture, and in this year (1796) a circular was issued by the Board of Agriculture, advising farmers to raise two crops of potatoes in one year on the same soil, with instructions how this was to be attained. It was also stated that the potatoes could be followed by a crop of coleworts.

The "New Statistical Account of Scotland" was published in 1844, although the accounts of the various parishes may have been written several years before this date, and usually by the minister of the parish. From these accounts can be gathered the important place now occupied by the potato in the husbandry of the country. I shall quote from that work the account given of the Parish of Redgorton by the Rev. William Liston, in which he says, "The principal dependence of the farmers in this parish, as in the rest of the county, is on the potato crop. The Perthshire reds have for a number of years held a high place in the London market. The price, however, has been very fluctuating, having varied from 7 shillings to 15 shillings per boll of 18 stones. An average crop, on tolerably good ground, may vary from 30 to 40 bolls an acre, so that crops of potatoes are the most valuable that a farmer can raise, and it is only from this circumstance that they have been able to pay their rents." And he goes on to state that within recent years farmers had met with great losses owing to the potato sets failing to germinate when planted. Seeking a reason for this failure, he believes that the planting of sprouted sets is a contributory cause; which contrasts strangely with our modern beliefs and practice of sprouting all potatoes before planting. The writer also suggests, that the potato, the Perthshire red, was gradually failing, having been in existence for 60 years, although not in general cultivation so long, but its age must be determined by the number of years it has been planted, and not by the extent of its propagation. It is obvious that the remote cause can only be removed by having recourse to plants recently raised from seed, which is the method provided by nature for the preserving and renewing of her products. Forty years later a Parliamentary Commission, and the Royal Society, could only give the same advice for the failure of the potato as the Parish Minister. The Perthshire red here mentioned, I have found, from another source, came into general cultivation about 1808, and must have passed out of cultivation not long after 1845, as, twenty years later (to which, unfortunately, I can look back) it was but a memory, although a fragrant one, as I frequently heard its merits extolled. To those then living who remembered it, there was no potato to compare with the Perthshire red. I was fortunate to come across a description of this potato, in which it was stated that it grew to a great size, but was of a very irregular shape. It must, however, have had a high starch-content, as one often heard in homely phrase that, when made into soup, it boiled down into a glue-like mass, in which the stirring utensil stood upright in the pot!

The value of the potato to the county at large is very clearly set forth in the Account of Perth in the "New Statistical," where it is stated that, in 1836, the quantity of potatoes shipped from Perth for the London market was 27,114 tons, or 108,456 Scotch bolls. The value in Perth was about £65,000, the value in London, including freight, being about £101,000.

In the autumn of 1845, the country was startled by the advent of a disease affecting the potato crop. In 1842 this disease had been heard of in Germany. The following year it had ravaged North America. The meteorological conditions over all Europe had been of an abnormal character in 1845. Up to the middle of July, the weather had been of a favourable character, with great heat experienced on the Continent. This was followed by almost incessant rains, until the end of August. The disease was first noticed in the Isle of Wight, but it travelled rapidly northward, and the potato crop in many parts of the country was almost a total failure. Although there was a general consensus of opinion that the predisposing cause of the disease was the abnormal nature of the season, yet there was a feeling of helplessness arising from the ignorance of the immediate cause itself. This is reflected in a circular issued by the Highland and Agricultural Society to its members, to the following effect:—" Desirous of obtaining information regarding the disease which has so recently affected the potato crop, the country earnestly desires the co-operation of societies and individuals in the collecting such facts regarding the disease as the experience of agriculturists in different parts of the country may supply. Although curl and ulceration of the tubers are known to have affected the potato since the period of its general cultivation in these Islands, yet these were local and partial, and there has been partial failures of crops apparently from the sets undergoing decomposition in the ground before they had sent forth stems. But in the disease in question which has caused such general alarm, the plants have appeared to grow vigorously in their first stages, only to become perceptibly or seriously affected as they approach maturity. What the cause of this dangerous disease may be, we do not know. The disease has more than once ravaged North America, and several years ago it appeared in the Island of Mull, and a few of the Outer Hebrides, but it was only in the past year it has appeared over the greater part of Europe. We may indulge in the hope it may not return, or occur in such violence, and therfore the Society has felt it a public duty to collect all the information which the best experience affords." This appeal is followed by a number of questions, but neither these, nor the numerous replies which the circular called forth, have any interest for us now. It may, however, be stated that potatoes in all parts of the country were not affected. Sutherland, Caithness, Orkney, Moray and Nairn reported no disease, while in Aberdeen and Kincardine they were only slightly affected.

Since its first appearance, in 1845, the blight has been the subject of much investigation, and it has long been known that the disease is due to the attacks of a parasitic fungus, although certain circumstances connected with its attacks on the potato still remain obscure. For many years the blight has been accepted in the country as an evil to which the plant is liable, its occurrence being governed by the same meteorological conditions as those under which it first appeared—namely, warmth, with an abundant rainfall during the latter half of July and August; and, further, if this period should prove dull and sunless, the conditions are still more favourable for the propagation of the disease. Although most people can recognise a diseased tuber, yet few seem to know anything of the disease, or even recognise its first appearance on the leaves of the plant. Visiting a gentleman's garden some time ago, I called the owner's attention to the blight showing on the leaves of his potatoes, but he was frankly incredulous.

Before speaking of the blight, I should like to say a few words on the Physiology and Morphology of fungi. The outstanding difference between fungi and the more familiar green-leaved vegetation is the absence of chlorophyll in the economy of the former. Devoid of chlorophyll, fungi are unable to assimilate carbon-dioxide from the atmosphere, and have thus to find their sustenance in those substances which have already been prepared by a plant or animal. The great majority are saprophtes, living in the humus of the soil, on dead wood, herbaceous stems, dead leaves, etc. Others are parasites, living in the interior of their hosts, hindering their development, or killing them outright. Fungi arise as the product of a spore germ-cell, from which they issue as delicate tubular threads, which branch freely, the branches often uniting again at certain points of contact. This mass of branching threads is termed the mycelium, or spawn, while the individual threads are known as the hyphae. The mycelium has no roots, but it is endowed with the properties of roots, and capable of absorbing its sustenance from the substratum on which it grows. Amongst fungi are to be found a number of very different types. In one of these, the mycelial threads unite to form these large growths with which we are familiar as mushrooms, toadstools, and puff-balls. These growths constitute the part of the plant devoted to reproduction, and on which the spores are borne in myriads. In another type, the mycelium alone constitutes the plant; and the reproductive bodies are borne directly by the mycelial threads. These highly organised mushrooms and toadstools may be said to hold the same status among fungi as the arboreal and herbaceous vegetation amongst the higher plants. These simple types might be compared with the Algae of our ponds and streams. To this simple type of fungi the potato disease, **Phytophthora infestans,** belongs. It is one of a group termed the Perenospora, in which are found a number of destructive parasites.

An attack of the blight is at first manifest on the leaves of the plant as brown spots, which rapidly become black, as the tissues are killed. The epidermis of the leaf is not directly affected. The fungus, being ensconced amongst the succulent cells of the interior, the epidermis affords the necessary protection to the fungus. In this it resembles the operation of the larvae of certain insects, the leaf-miners, whose devious wanderings may be traced as a white line on the surface of the leaf attacked. When these spots on the leaves are closely examined, a slightly mildew-like appearance may be detected around the margin on the underside of the leaf. When examined with the microscope, this is seen to be a miniature forest of branching threads, bearing at their apices minute ovate bodies, termed conidia. These branching threads are continuous with the mycelium in the interior, and have found their way through the pores of the leaf, the branching being subsequent. The conidia represent one stage in the reproduction of the fungus. These bodies are light, and easily moved by air currents, and should they be carried where moisture is present, germination takes place, and eight zoospores are produced. These bodies are very minute, and are furnished with two cilia, or hair-like processes, by which they can swin in moisture, animal fashion. Should the zoospores fall on a leaf of the plant, and sufficient moisture be present, germination takes place, and a minute tubular growth issues, which either pierces the leaf, or finds its way into the interior by the breathing pores. The mycelium, the new plant, arises from the subsequent growth and branching of this primordial tube. Ramifying in the interior of the leaf, the fungus does not enter the cells, but confines its ravages to the cellulose of the cell walls, which it dissolves and absorbs. Its attacks are not confined to the leaves. The stems are also affected, and the rapidity with which the stems of a badly infested field collapse and putrefy is remarkable.

Marshall Ward, in his "Diseases of Plants," believed that the disease passes down the stems and attacks the tubers, but at the same time he considers it highly probable that the myriads of conidia which must fall to the ground beneath the stems may get washed into the soil, and these, coming into contact with the tubers, will germinate, and set up the disease. He was, however, of the opinion that this will only take place where the tubers are in a young state, before the skin thickens. He adds that it might be expected that varieties will differ in their susceptibility to the attacks of the fungus in this manner. More recent investigation has aroused doubts as to this theory of the disease passing down the stem, but the belief that the tubers are affected by these fallen conidia receives support from the fact that if at an early stage of the disease the plants receive a second moulding, or "earthing up," as it is termed, the loss from diseased tubers is much less.

In many of these algae-like fungi, akin to **Phytophthora infestans,** resting spores are produced, which carry the fungus over unseasonable conditions. But no resting spores are known to occur in the potato disease, and it is propagated from year to year by the hibernation of the mycelium in the tubers. When diseased tubers are left in the soil, they quickly become putrid, and disappear; but if only slightly affected and stored in a dry condition, the mycelium becomes dormant. Massee, in his "Text Book of Fungi," gives the results of a series of experiments conducted at Kew in order to determine this question. These showed conclusively that the mycelium hibernated in the tuber. And, when these diseased tubers were planted, the mycelium awoke to activity, ascended the young shoots, but only developed in the leaves when conditions were of a favourable character. No one, of course, would knowingly plant diseased tubers, but the presence of the mycelium in the tuber, when it is only slightly affected, may be easily passed over.

In Britain, the disease may be said to have run its course in the one season, as the crops of the following year were scarcely affected, but in 1846 and 1847 the disease ravaged Ireland, and the far-reaching effects of this in the history of that country is well known. The disease, however, has never been lost; and, twenty-five years later, a series of disastrous seasons threatened to make the cultivation of the plant impossible. In 1872, the potato crop of the country was almost totally destroyed, the varieties then in cultivation showing no disease-resisting powers. In 1876, the Messrs. Sutton introduced the Magnum Bonum, and the high disease-resisting powers of this potato were of the greatest service to the country. About this time, also, a number of American varieties were introduced, amongst which Early Rose and Beauty of Hebron were highly valued, the latter still figuring in the latest list of cultivated varieties. This source of supply, however, was cut off by the breaking out of the Colorado beetle scare in America, and the Government forbade their importation. In 1880, a Committee of the House of Commons, reporting on their inquiries into the potato disease, stated that all witnesses were unanimous in the necessity for the production of varieties with increased powers of disease-resistance. The high disease-resisting powers of Magnum Bonum suggested the possibilities of raising varieties immune to the disease. This has not yet succeeded, although varieties are sometimes raised possessing this quality in a marked degree, but this invariably declines with lengthened cultivation.

The cultivation of the potato is carried on by the planting of the tubers. When small, these are planted whole, but, when large, are cut into several pieces, each having one or more eyes, or buds. The planting of cut seed has in recent years fallen into abeyance, the small whole tubers being preferred. This is a vegetative method of reproduction, and, theoretically, no reason can be given why it should not continue indefinitely. Practical experience, however, has shown that all varieties decline in vigour, or, as it is said, "run out." A change of seed from one part of the country to another, where soil and climatic influences are different, as a means of stimulating or restoring the vigour of the plant, has been popular. It has been learned from experience that the best results are obtained where the seed is imported from a northern region, and it is this experience which is the basis of that somewhat extensive trade in Scotland in growing seed potatoes for English farmers. The superiority of the northern seed has often in the past been attributed to the circumstance that, the potato being grown under cooler conditions, the tubers are less fully ripened, and thus provide more vigorous seed. This superiority of the northern seed is not permanent, only lasting for two seasons, when fresh importations have to be made.

Within recent years, a very different reason has been advanced for the superiority of the northern seed, and the deterioration of the potato in the warmer parts of the country. This has arisen from the discovery that many plants suffer from what has now come to be called the Virus Diseases. Little is known as to the nature of these diseases, but it is believed that they are infectious. Those affecting the potato are known as "leaf mosaic," "wrinkle," and "leaf roll." These diseases do not kill the plants affected, but lower their vitality and consequently their cropping powers. It is urged that the superiority of the northern seed arises solely from the fact that, being grown under cooler conditions, the plants are comparatively free from those virus diseases which sap their vitality in the warmer parts of the country, and by which the imported seed quickly becomes affected when exposed to the same conditions.

In the propagation of the potato by planting the tubers, there is no rejuvenescence of the resulting progeny, but in raising them from seed the sexual organs are involved, and the result is a new plant. In most plants, the progeny resemble the parents, or, as it is called, breed true to type, but, in the potato, this does not obtain. There is no difference in this, whether the plants are raised from seed naturally produced, or as the result of the hybridisation of two varieties. The progeny differ, not only from the parent plants, but also among themselves. This is shown in the foliage and the colour of the flowers, but especially in the tubers. One sometimes hears of the necessity for the employment of more scientific methods in the raising of new varieties, but one can hardly doubt that our agricultural colleges and associations are alive to this matter. An insuperable difficulty exists from this habit of **Solanum tuberosum** in producing a heterogeneous progeny, amongst which the finding of a variety, of sufficient merit to satisfy the requirements of the agriculturist and the consumer, is entirely fortuitous. Apropos to the subject, there appeared in the "Scotsman" of November 25 the results of potato trials at Ormskirk, under the auspices of the National Institute of Agricultural Botany, in which is recorded the presentation of a gold medal to Mr Donald M'Kelvie, of Arran, for a potato raised by him, and called the Arran Banner. It was also stated that this potato and another were all that remained to Mr M'Kelvie out of 3000 seedlings raised by him in 1922. So slight is the margin between success and failure!

Solanum tuberosum is said to breed true when freshly imported from its native country, and as to how, or at what date, this remarkable change occurred, no information can be gleaned. It has been sometimes ascribed to the breeding of varieties, but this affords no explanation of how these varieties arose. It may, however, be surmised that the methods employed in its cultivation have not been without considerable influence in this change. When potatoes are planted, and receive no further attention, the tubers will be found to have forced their way to the surface, and then to have developed chlorophyll, which the "moulding" process necessarily prevents. Until quite recently, the value of chlorophyll in the seed tubers was not recognised. Now, however, the "greening" of the sets is found to enhance their vigour. Another influence might be cited in the intensive cultivation of the potato by planting the tubers the vegetative method, and the consistent selection of those varieties showing a high tuber production. This may have disturbed that equable balance which might be assumed to have existed in the plant, in a state of nature, between the reproductive and vegetative methods of perpetuating the species. It is patent to elderly people that the reproductive organs of the potato are being affected in another manner. Forty years ago, in looking over a field of potatoes, the fruits, or "plums," as they were called, could be seen hanging from every plant; but these are now never seen. The immediate cause of this is traced to the slow maturing of the stigma or female organ of reproduction. It is quite conceivable that at no very distant date the potato might become absolutely sterile.

I purpose bringing this rather discursive paper to a close by a brief mention of another serious disease affecting the potato. This is known as the "wart disease," **Synchytrium endobioticum,** which appeared in this country about the end of the nineteenth century and was believed to have been imported from the Continent. This is also a fungus disease, and first attacks the eyes of the tubers, but finally reduces the whole tuber to a mass of black warts. Fortunately, only certain varieties are subject to its attacks, and the immunity or otherwise of a variety can be determined in the laboratory. I am not aware if any reason can be advanced for this partiality of the fungus for certain varieties. Restrictions are in force against the planting of non-immune varieties, but this seems only to apply to cultivation in a small way. It is rather surprising to find from the Board of Agriculture Returns for the year 1927 that out of the 147,184 acres of potatoes grown in Scotland during that year, more than 50,000 acres were devoted to the culture of non-immune varieties.

My thanks are due to Mr. Ritchie for the lantern slides he has so kindly provided me with, and also to Mr. Watson for the discovery of many of these notes of the history of the potato, which I have used so freely.

XXVIII.—*Note on the Discovery in Perthshire of a Rare Fungus, Blitrydium caliciiforme, De Not.*

By JAMES MENZIES.

(Read March 9, 1928.)

I found some indifferent specimens of this curious Discomycete four years ago, on the bark of some fine old sycamore trees at Chapel Hill, Logiealmond. Visiting the spot some little time ago, in company of Mr. White, we found it again in some quantity, and in fine condition. The plant, as we found it, occurs in little patches, each plant appearing through the bark independently. It is easily identified, when subjected to microscopic examination, by the four-spored asci, and the large muriform spores. Although described by both Cook and Massee, I can find no record of its being found in Britain. The reason, perhaps, for this apparent rarity arises from the plant's occurrence on the bark of living trees, which are rarely scrutinised by fungus collectors, and it is more likely to be found by lichenologists.

XXIX.—*Note on the Discovery of a Fungus Rare in Perthshire, Phallus imperialis, Schulz.*

By JAMES MENZIES.

(Read March 9, 1928.)

Early in September of last year a fungus was sent to me from Dunkeld by a gentleman who was not familiar with the fungi in any way, but was attracted to the plant by what to him was its singular appearance, and he was desirous of knowing something about it. While there was no difficulty in recognising it as the peridium of a **Phallus**, known as the stink horns, there were certain characters in the plant which separated it from the two species of Phallacea hitherto found in Perthshire. These were the reddish colour of the peridium and the absence of that very unpleasant odour associated with **Phallus impudicus.** Suspecting it might be some abnormal form of the above-mentioned, I wrote to the gentleman asking him to try and find some more examples, and, if possible, in a more fully developed condition. In reply, he sent on half-a-dozen, still in the same condition as the first.

Knowing that the British Mycological and Scottish Cryptogamic Societies were in session at Aviemore, the specimens were submitted to them. Mr. Carleton Rea kindly wrote assuring me that the plant was **Phallus imperialis,** Schulz, and, at the same time, stated the species was very rare in Britain, occurring, so far as he was aware, only in Norfolk. It might be deemed strange that this plant was found at Dunkeld, Where our old friend, Mr. Charles M'Intosh, spent so many years of his life in fungus collecting, and never saw this plant, and that it should fall into the hands of a person only actuated by curiosity as to what it was.

XXX.—*The Diatoms of the Balthayock Lochs.*

By GEORGE F. BATES, B.A., B.Sc., F.R.M.S.

(Read March 9, 1928.)

A visit to the lochs of Balthayock in May, 1927, yielded the diatoms mentioned in the following list. Gatherings were made at three principal points—(1) In the lower loch, on the bottom and on Myriophyllum. By far the most abundant species here was Fragilaria capucina. (2) On the concrete of the outlet channel of the upper loch. Brown gelatinous masses were here very abundant, and consisted chiefly of Gomphonema constrictum. (3) In the upper loch, immediately behind the retaining wall. Here a considerable quantity of loose Myriophyllum had collected, and the epiphytic growth on this consisted of numerous species of diatoms, many of them very small and difficult of determination. The genus Synedra was very conspicuous, especially S. splendens and S. pulchella. Floating freely among the masses of Myriophyllum there was abundance of a yellowish-brown material, in which the most conspicuous species was Cymbella lanceolata. The other species listed were found associated with those mentioned above. The relative abundance varied considerably, some being represented by numerous individuals, others by comparatively few. It is not claimed that this list is complete—several species in the gatherings are as yet unidentified—but it does contain the names of those species which were most abundant at the date of the visit.

I.—Sub-Order **Raphideae.**

Amphora ovalis.
Cymbella lanceolata.

C. Cistula.
C. cuspidata.
C. Helvetica.
Encyonema caespitosum.
Navicula viridis.
N. acuta.
N. rhyncocephala.
N. cuspidata.
N. crassinervia.
N. interrupta.
N. ambigua.
Pleurosigma lacustre.
P. attenuatum.
Gomphonema constrictum.
G. capitatum.
G. dichotomum.
Rhoicosphenia curvata.
Achnanthes exilis.
Cocconeis Placentula.

II.—Sub-Order **Pseudo-Raphideae.**

Synedra ulna.
S. splendens.
S. pulchella.
Fragilaria capucina.
F. mutabilis.
F. Harrisonii.
F. undata.
Diatoma vulgare.
Cymatopleura elliptica.
C. Solea.
Surirella biseriata.
S. linearis.
Nitzschia sigmoidea.

III.—Sub-Order **Crypto-Raphideae.**

Melosira varians.
Cyclotella operculata.

XXXI.—*Recent Observations among the Birds of Tentsmuir.*

By E. CRAPPER.

(Read March 9, 1928.)

In deciding what to tell you this evening concerning my recent observations among the birds of Tentsmuir, I have thought it best to give you a more or less complete and connected account of the history and home-life of two or three only of the birds frequenting this area, rather than try to present to you a list of miscellaneous and unrelated records of all the birds nesting there. I have chosen for this purpose the Sandwich Tern, the Roseate Tern, and the Dunlin, as these three birds have been prominently before my notice in recent years. I will, therefore, start off with the Sandwich Tern.

THE SANDWICH TERN.

The Sandwich Tern has been established on Tentsmuir for a considerable number of years now. I have known of its presence there since 1907, but it has undoubtedly been there much longer than that.

It used to nest fairly regularly under a nominal protection until the war years, but during the time of stress and food scarcity towards the end of the war, all protective measures were withdrawn. The result was obvious. Eggs of this bird, along with those of all other birds nesting on the moor were ruthlessly collected for food, so it is not surprising that at the end of the war the Sandwich Tern had ceased to return to the moor for nesting purposes.

However, by 1922 we find this Tern attempting to re-establish itself there, and every year since has seen an improvement of its position. Colonies of from 20 to 450 pairs have been the rule since then, but from year to year the numbers frequenting the moor fluctuate considerably. 1923 was a very successful Sandwich Tern year, two large colonies—one of 450 pairs, the other of 150 pairs—being present.

This Tern is extremely gregarious in its nesting economy, large colonies of nests, numbering hundreds, occupying quite small patches of ground. It is a sight worth travelling far to see a really big colony. At the approach of a visitor, the whole crowd rises in the air over the nesting area, emitting deafening cries all the time. Its call-note is harsh and penetrating, with an aggressive quality in it, and might be written as "jickuk.

jick-jick-uk, jick-jick-uk," with variations. Its flight is typically Tern in style and finish, if anything somewhat heavier than that of the other Terns, and is certainly not so polished as the graceful flight of the Common and Arctic Terns.

It nests slightly earlier than the other Terns, the colonies being generally placed on the open sea-shore, on or among the sand-dunes, and also on coarse grass-land and in heather. No nest in the real sense of the word is made, a mere hollow in the sand or ground meeting its requirements in this respect. The eggs, usually two to a nest, are remarkably handsome, and vary a great deal in marking and colouring. In a large proportion of the nests the eggs composing the clutch differ so much from each other as to raise serious doubts as to whether the same bird actually laid them. I am strongly of opinion that Sandwich Terns lay indiscriminately in each others' nests. I have paid particular attention to this point, and have carefully examined many nests. Great numbers of the nests containing two eggs hold eggs of entirely different pattern, and very often of shape as well. Only quite a small number of nests contain well-matched pairs of eggs. On the other hand, it would be quite an easy matter to pick up eggs from different nests, and to match them, so that no reasonable doubt of a common parentage could be raised. As a partial test, two sets of badly matched eggs were taken at random and blown, and in each case the state of incubation of the two eggs forming the sets varied to a remarkable degree, as much as one week's difference in incubation being evident.

The Sandwich Tern at home is not a sanitary bird. The nesting-ground very soon becomes foul with the birds' droppings, so that the grass, etc., around the nests has quite a frosted appearance. Quite an interesting point in this connection is that at the beginning of the period of incubation a distinct "cart-wheel" pattern surrounds many of the nests, and this particular point in the nesting economy of the Sandwich Tern is, I believe, quite unique and characteristic. In course of incubation, however, these "wheels" disappear, becoming merged with each other, and finishing up in an ever-growing whiteness all around. As a result of this unsanitary condition of affairs, there hangs around the nesting-ground a distinctly "musty" odour, very soon recognised as typically "Sandwich." The deserted site of a Sandwich Tern colony can long afterwards be identified, for the concentrated mass of droppings quite kills off all vegetation that may have been growing previous to occupation.

The Black-headed Gull is a serious menace to the Sandwich Terns, as every year heavy raiding of the nests for eggs by these Gulls takes place. It is a sorry experience to visit a thriving colony day after day, and to see it gradually diminishing in size through the depredations of the Gulls. Broken and partly sucked eggs more and more numerously replace the live eggs, and it has happened more than once that a colony has been exterminated by this attrition. Some colonies seem to be better able to withstand this kind of attack than others; consequently, and happily, a fair proportion of Sandwich Terns hatch out every year. It is astonishing that such a large bird, and nesting in compact colonies as it does, should be so powerless against this kind of attack. I can assure you that any Gull that approaches a nest of the Common or Arctic Tern with evil intent is courting trouble, as these species allow no interference of this kind.

The young of the Sandwich Tern are pretty little things, and very soon leave the nest and scatter all around, a general drift towards the shore being noticeable. When critically examined, the young of the Sandwich Tern are seen to vary in shade one from another, some being quite light in general tone, others distinctly dark. In trying to account for these two shade types, is it permissible to suggest that the light ones are the product of the light eggs, and the dark ones of the heavily marked eggs?

Towards the end of the summer, imperceptibly but surely, these Terns, with their growing young, leave the moor, and more and more congregate on the sandy shore adjacent to the moor.

It is difficult to collect data on the subject of moulting in respect of birds that leave us so soon as the Terns do, but I have repeatedly noticed that in early August, when many of them are still feeding helpless young, the Sandwich Tern shows distinct signs of reverting to its winter plumage. The jet-black crown on its head begins to break up, and white streaks become more and more evident.

To wind up, I am happy to be able to state that at present the prospects of a continuous and prosperous future for the Sandwich Tern on Tentsmuir are good.

THE ROSEATE TERN.

It gives me some satisfaction to be able to definitely record the nesting of the Roseate Tern on Tentsmuir, as on the 18th of June, 1927, I located a nest of this rare Tern on the northern half of the moor. For some years past I had been suspicious that this Tern was frequenting the locality, as on several occasions during the summers of the last three or four years I identified either a bird or a pair of birds of this species mixed with the other Terns nesting there. It was not until 1927, however, that I obtained definite proof of their actual nesting.

Before going further, a word on the identification of this bird might be of value. In the first place, a thorough understanding and recognition of the call-notes of the other Terns present on the moor—the Common, Arctic, Sandwich, and Lesser Terns—is absolutely necessary. Given this ability, a new or strange call-note is at once noticed, no matter how many or how noisy the other Terns may be. It was, therefore, in this way that I first sensed the presence of this stranger, and from this point the actual visual identification of the bird was not difficult. The call-note of the Roseate Tern is quite distinct from those of all the other Terns, and is unmistakable when once learned and memorised. It may be likened to a particularly harsh rendering of the squeak of a new and squeaky pair of boots, emitted in short jerks. It is not loud when compared with the terrific volume given forth by the other Terns.

The flight of this Tern is also in a subtle way different from that of the other Terns. It is lighter and more fairy-like, and somewhat reminiscent of the flight of a Plover, the wing-beats being more rapidly executed than is usual in the Tern family.

It is needless to emphasise the presence of the characteristic pink breast and almost black bill—the two main distinguishing features of this Tern. It is almost impossible to note these details when the bird is in the air, but when it is on the ground they stand out prominently and proclaim the identity of the bird. The pink tinge on the breast is beautiful beyond words, and seems to imbue the bird with an atmosphere of purity and warmth. It appears to be more of a "reflection" or a "blush" than of a definite colour. This pink tinge is, strangely enough, more intense to the eye in dull weather than in bright sunlight, the sun apparently overpowering the comparatively weak tint.

Two other small but quite noticeable points of difference that help to proclaim this Tern are (1) the streamer feathers of the tail are proportionately longer and the outer feathers of the wings proportionately shorter than in the other Terns; and (2) the body colouring is pure white, as against the distinctly greyish tinting of the Common and Arctic Terns. A Common Tern's nest was situated only a couple of yards from the nest of the Roseate Tern, and as I watched these two birds on the nest from a distance, the difference between them was startling. The Roseate Tern, due to its pure white colour, looked clean and brilliant; while the Common Tern had a dingy, almost dirty appearance. The carriage of the two birds as they sat on their nests was also noticeably different. The tail of the Roseate Tern seemed to be raised above the body, and, when seen from the front, the effect of this was unusual.

To come now to the actual recording of nesting in 1927. Early that season I spotted a pair of Roseate Terns on the moor, but, after watching them for some time, I satisfied myself that they were not then nesting. Later on, on the 18th of June, I once more saw the birds at approximately the same part of the moor. This time I had no hesitation in saying they were nesting, the behaviour and concern of the birds being sufficient proof of that. I therefore seriously set about to find the nest. This was no easy task, as hundreds of nests of the Common Tern were all around, and the noise and tumult above made it difficult to keep the solitary pair of Roseate Terns in view. Concealing myself as best I could behind a sand-hill, I continued to watch them. After a while it became evident that the Roseate Terns were rather more than usually interested in a certain piece of ground on which a small colony of Sandwich Terns were nesting. I therefore decided that the nest, if in existence, must be near this spot. I then changed my location to give myself a better view of this piece of ground, and from this new point of vantage again saw the Roseate Terns hovering anxiously over the spot in question. It was only a matter of minutes afterwards when the hen (presumably) Roseate Tern gracefully dropped groundwards and settled on the nest. The nest was therefore before me, and with keen satisfaction I walked over to the spot and beheld for the first time the nest and eggs of this rare visitor. The nest was in no way different from many a Common Tern's, and could not be separated therefrom without the owner's presence. The eggs were similar to one of the many types of eggs of the Common Tern, and would be no help in identification. If anything, they were slightly and proportionately longer, and the spots smaller and more numerous. The ground colour was buffish-stone with greenish-brown spots.

A point worth considering is whether these birds deliberately settled beside the nesting Sandwich Terns. From small details that have impressed themselves on my mind during the past years whenever I have seen these birds, I have always been inclined to associate the presence of the Roseate Tern with that of the Sandwich Tern, so that I was not surprised to find its nest situated just at the front door of a colony of these larger Terns. It may be that this Tern follows the Sandwich Tern. But, of course, this is mere conjecture, and requires further investigation.

Such an event as the occurrence of this rare visitor could not be allowed to pass without some effort being made to secure photographic record thereof. I consequently at once made arrangements with this object in view, and on the following day returned to the nest for this purpose. The watcher saw me satisfactorily installed inside my "hiding tent," and then left me. The Roseate Terns were not at all suspicious of the tent, and my presence therein did not seem to bother them. Before ten minutes had passed since the watcher had left me I had secured my first snap. This bird became rapidly very tame, and soon my chief concern was to get it to leave the nest to give me opportunities to secure different poses. Each time I wished it to leave the nest I had to frighten it off, but these repeated alarms did not upset it in the least, for it returned each time within a minute or two. I was therefore enabled to get a useful series of photographs of the bird. The male was very attentive and "exacting" towards his mate. Each time she left the nest (generally at my "request"), he became greatly concerned at the eggs being left uncovered, and at once gave chase to the female, not desisting until he had her back on the nest again. He was never far away from the nest during my time in the tent, and when he was not looking after his mate, he was chasing away any intruders that were, according to him, passing over the border-line. I should say that the Roseate Tern was a courageous and fearless bird in the face of danger threatening the nest or young.

I would be about two hours in the tent altogether (two spells of about an hour each), and must have worried the female considerably with my repeated "invitations" to move. Despite this, the moment the tent was lifted and my back turned, she was on the nest, and for the rest of the week that I was able to pay her re-visits, she continued to brood closely and faithfully. And at this point my acquaintance with the Roseate Tern had to cease, as on the 25th June I left the locality on holiday.

THE DUNLIN.

The Dunlin, due to its insignificant size and unobtrusive colouring, has not received so much attention on Tentsmuir as several of the other larger and more attractive denizens of the moor, but it is none the less worthy of its due share of study.

As a winter bird, it is very common on the sand-flats fringing the moor, where it is universally known to the inhabitants of Tayport and district as "the croallie" or "crawlie." I can only explain this unusual name by supposing that the way this bird runs about on the shore when searching for food has given to these people the impression of "crawling."

Large flocks of Dunlin frequent the shore at this season, and it is one of the sights of nature to see a really big flock, numbering perhaps thousands, take to the air, and, in perfect order, and with mechanical-like precision, skim at great speed over the mud-flats or near-by sea. On a clear and sunny winter's day, such a flock, seen from a distance, looks like a rapidly moving cloud—now dark, as the backs of the throng are toward us, now silvery white, as, in an instant, the whole flock as one bird "reverses," and the white underparts are facing us. When engaged in these aerial evolutions, the flock seems to be ruled or guided by a master-mind, every bird answering with electrical rapidity to the will of this mind. Watching one of these flights is fascinating in the extreme.

The flock imperceptibly changes shape; now it is a perfect oval, now a pear-shaped mass, or again an attenuated line, but all the time the one-ness of the mass remains perfect. As suddenly as such a flight is undertaken, just as suddenly will it cease, and in a few seconds the flock will be scattered over the wet sands or mud-flats busily searching for food.

It is not, however, as a winter bird that I wish to speak of the Dunlin, but as one of the rarer and consequently lesser-known breeding birds of Tentsmuir.

The great majority of the wintering flocks migrate northwards in spring to their northern nesting-grounds, while a very small number remain behind in this country to nest. Tentsmuir is one of the favoured localities, and perhaps half a dozen pairs nest there now annually, although, prior to the war, quite a respectable colony, perhaps twenty pairs, nested regularly on the southern portion of the moor adjacent to the river Eden. The creation of a fairly large air station at Leuchars, close by, with the consequent coming and going over this part of the moor by airmen and others, has practically wiped out this unique colony. A pair or two do, however, still struggle for existence there. However, I am glad to say that at least two or three pairs appear to nest annually on the northern portion of the moor—that is, the portion near Tayport, and the part best known to me. The nest of the Dunlin is a very difficult one to locate, and is consequently comparatively safe from interference. I have seen only three nests of this bird in six years, and all of them were found by mere chance. The nest is a small and very neat and compact cup of dried grass, etc., situated in the heart of a clump of longish grass. It is consequently completely covered and invisible, even at close range. And as the bird sits very close, it is seldom located. A comprehensive description of the nest would be to describe it as a miniature Redshank's nest. The eggs, the usual four pear-shaped eggs of the Plover type, are extremely handsome, having a buff ground colour, lavishly covered with blotches and spots of reddish-brown.

I must draw attention to what I call the spring song of this bird. For quite a long time I was baffled to identify a very pretty "trill" that occasionally struck my ear when on the moor and open shore. It was strangely reminiscent of the song of some "land bird," but as such I could not place it. It was long before I traced it to the Dunlin. I have heard this "trilling" note only in the nesting season, and therefore consider it to be part of the breeding season behaviour.

I photographed the Dunlin at the nest in June, 1927, when I found it inclined to be shy and suspicious, and for some time after I had entered the hiding tent it hung about in the "offing" trying to make up its mind to return to the nest. It would tantalisingly wander about and around the tent at perhaps ten to twenty feet therefrom, ever so often making false moves forward to the nest. However, it finally did return to its duty, and its approach was the embodiment of care and stealth and suspicion. It just glided imperceptibly into the nest from out among the longish grass surrounding it. Due to its small size, its neutral colouring, the long grass, and its anxiety to keep out of sight as much as possible, it did not make a good photographic subject. However, I eventually secured a small series of snapshots of it, on and off the nest; and although they may not be pictorial studies or "pretty" pictures, I trust the natural history interest of them will make up for this lack of beauty.

At Mr Ritchie's request I annex hereto a list of all the birds I personally know to breed or to have bred on Tentsmuir. It would have been possible to extend this list by including the more common land birds that nest in the woods on the Kinshaldie and Earlshall portions of the moor. Further, in limiting my list to the birds actually nesting there, I, of course, again considerably restrict the list. If I was to add to the list all the birds that usually or rarely visit the moor and the adjacent shore, it would show that a very large proportion of the birds on the British list have at some time or other visited the locality. I therefore think a list of the actual nesting birds represents more truly the avian inhabitants of the moor, and gives a truer idea of its bird life. Outside the nesting season the moor itself is almost completely deserted of bird life; the centre of bird life being transferred to the adjacent shore. A long time ago there was an invasion of Sand Grouse into the moor. There is a record of the Dotterel having been obtained (shot) there; this bird is in the Dundee Museum. Then in the Perth Museum there is a fully matured female Black Tern, got on the 30th of June, 1885, on Tentsmuir. Also it is interesting that Perth Museum has a young specimen of the Black Tern obtained on Mugdrum Island, in September, 1901. I have also reason to believe that the Greater Black Backed Gull, the Long Tailed Duck, and the Greenshank, have nested on the moor, but I can give no evidence in support.

List of Tentsmuir Nesting Birds.

1. Kestrel.
2. Long Eared Owl.
3. Tawny Owl.
4. Stonechat.
5. Whinchat.
6. Wheatear.
7. Sedge Warbler.
8. Golden Crested Wren.
9. Pied Wagtail.
10. Meadow Pipit.
11. Sky Lark.
12. Reed Bunting.
13. Twite.
14. Linnet.
15. Starling.
16. Carrion Crow.
17. Cuckoo.
18. Swallow.
19. Sand Martin.
20. Ring Dove.
21. Stock Dove.
22. Pheasant.
23. Black Grouse (once only).
24. Red Grouse.
25. Partridge.
26. Golden Plover.
27. Ringed Plover.
28. Lapwing.
29. Curlew.
30. Redshank.
31. Common Snipe

32. Dunlin.	36. Teal.	40. Common Tern.
33. Water Hen.	37. Eider Duck.	41. Arctic Tern.
34. Shell Duck	38. Sandwich Tern.	42. Lesser Tern.
35. Mallard.	39. Roseate Tern.	43. Black Headed Gull.

XXXII.—*Antiquarian Notes on Tentsmuir.*

By JOHN RITCHIE, F.R.A.I.

(Read March 9, 1928.)

Abv. Note:—**P. S. A. of S.** means Proceedings of Society of Antiquaries of Scotland.

Fully a year ago, to be exact, in November, 1925, the Museum became custodier of a collection of stone, bronze, and other relics of the past through the kindness of the collector, Mr. Arthur G. Wilson, a native of Tayport, who, for the ten years between 1896 and 1906 had systematically collected on the area at the mouth of the Tay, known as Tentsmuir. The value of the collection is mainly due to the simple precaution Mr. Wilson took of registering the exact locality of each find at the time. As there were 273 specimens, all with recorded data, I was very glad that before Mr. Wilson returned to America he deposited the collection here. At the time I promised to attempt to get a report made on them, but time has gone on and I have been unable to fulfil the promise. With considerable trepidation I venture to submit a short analysis of some of the most interesting specimens in his collection, and at the same time take into consideration other material from the same locality from various donors in our Museum. I have also been enabled to examine Dr. Blair's collection in the Dundee Museum by the courtesy of the director, Mr. Webster, and of Mr. Duncan, the curator. Although there is quite a representative collection, both in Dr. Blair's collection, and also in the Sturrock collection, at Dundee, unfortunately there is no data regarding when or where the specimens had been obtained, only the general term attached—Tentsmuir.

The area known as Tentsmuir is situated on the southern bank of the mouth of the River Tay; it is the north-eastern portion of the county of Fife, and is the part of main interest to the naturalist and students of the past, lying between Tayport in the north to the mouth of the Eden as its southern limit. Its geographical and historical features formed the subject of a paper by Hutchison, read before this Society, and published in the transaction, Vol. IV, pt. 4, 1907, pp. 174-186, with an appendix to it by Dr. S. J. Shand and Mr. D. Rollo, describing a series of shell mounds or kitchen middens near Guardbridge. The best description of the whole area is that given in a paper which has been reprinted from "The Scottish Geographical Magazine" for December, 1904, entitled "Botanical Survey of Scotland" III and IV—Forfar and Fife, by Dr. Wm. G. Smith. Therein are described the general geographical features of this area. Near Tayport and at the mouth of the Eden, small tracts of muddy salt marshes are found. On the sandy shore and sand banks below the high water limit numerous seals are to be seen resting; then above the high water limit are a series of irregular and interrupted sand ridges averaging about ten feet in height, and extending inwards a considerable length. Their directional run is mainly south-west to north-east, except at Tentsmuir Point, where they follow the curve of the coast line. There are only two or three of these ridges at this point, behind these the surface assumes a slightly undulating aspect with broken areas covered with grass heaths and the gradual development of a succession of various plants at places where hollows have been formed. The ground at times is marshy, and it is there the nesting places of the terns and gulls, described by Mr. Crapper, are to be found. Farther back is a heather vegetation area, intersected at places by ditches, which have been dug to drain what must have been marsh land of considerable extent; here are the nesting places of the eider duck, also the black-headed gull.

There are one or two good farms, and near the centre is to be found a large quantity of Scots fir growing. Much of this has been cut down in recent years.

Articles of an antiquarian interest have been found, and these cover the stone age (neolithic) period, bronze age, mediæval, and more recent times. In many ways the specimens found resemble those obtained at Glenluce and the Culbin Sands. To accompany this paper I have photographed several of the specimens, which I venture to hope will elucidate them better than a long description.

Beads (all of them isolated examples), in Mr Wilson's collection have been found in the vegetation area. Beads of vitreous paste, jet, amber, and glass were obtained on the lands of Garpit and Shanwell. I was able to examine all of them through the courtesy of Mr Lumsden with his Mercury Vapour Analyser Cabinet; from what this method of examination revealed, both by using the Ultra Violet Ray and also through the invisible ray produced by the use of a special filter, blue glass beads which to the eye looked the same, under the inspection of this lamp showed startling differences, indicating that the chemical composition of the beads was entirely different.

The following table of beads, illustrated by plate 39, gives the data as revealed by the ultra violet ray and also by the use of a filter to exclude all the rays except the invisible ray. I have added a column to compare them with the type numbers of the glass beads as arranged in a paper by Mr. Ludovic Mann in P. S. A. of S., Vol. 40, 1906, p. 401, except that those under his Type 8 were rounded at the edge instead of going into a cone shape in section.

Bead Nos. Pl. 39 Figs.	Material.	Colours under mercury vapour lighting.	Colours under invisible ray	Perth Museum nos. and locality where found.	L. Mann's type nos.
1, 3, 4, 5, 7,	Jet.	Black.	Black.	2644, 2639, 2646, 2645. All from Shanwell. 2640 Garpit.	8
2	Amber.	Greenish.	Velvety brown.	2661.	8
6	Either a paste or disintegrating amber.	Greenish.	Dark brown.	2655 Garpit.	3
9	Pale blue glass.	Purple blue.	Blue.	2660 Shanwell.	4A
11	Dark blue bead.	Purple blue.	Blue.	2658 Garpit.	3
10	Pale blue bead.	Pale blue.	Blue.	2656 Garpit.	3
12	Small dark blue.	Dark blue.	Dark blue.	2659 Garpit.	4A
8	Vitreous paste star-shaped.	Greenish.	Dark brown.	2657 Garpit.	10

As regards the filter to block the ultra violet rays, other filters might be used which would show an entirely different result. The filter used at the time had been obtained for experimental purposes and was only obtained for use as a blocking screen to cut off the violet rays.

In Fig. 8 I have outlined a suggested completion; if it had been perfect it might have been a five-pointed star, similar to those which have been found on Glenluce and the Culbin Sands. This specimen is recorded in a note by Mr. J. Graham Callander, on p. 257, Vol. 60, P. S. A. of S.

Pottery.—Only once have all the pieces of an urn been found which could be restored; it is illustrated as Fig. 13, and is of the sub type y1 of the Beaker Class, as classified by the Hon. J. Abercrombie, Vol. 38, P. S. A. of S. I have been enabled, by the kindness of Mr. J. Graham Callander, to obtain an electrotype of the illustration of it as it appeared in the P. S. A. of S., Vol. 17. The urn stands 5 inches high and is 5 inches across the mouth. It was found by Dr. Berry on Tentsmuir and is in the Dundee Museum. In August, 1924, Mr. Jas. Smith of

Tayport obtained fragments of a large urn containing human bones, Fig. 13a. The type is similar to Abercrombie's y4 classification, and is about 10 inches across at the shoulder, but has a decided angular shoulder. It was found on the Tayport golf course, and has been roughly put together as an exhibit in the Dundee Museum.

There are quite a number of fragments of various types of urns in Mr Wilson's collection, the largest being figured as No. 19 from Garpit. This was in two pieces; it is of a dark, heavy nature, the composition of the clay material being very rudimentary, with irregular small pricked marks forming the design. Figs. 14 (Garpit) and 15 (Garpit) are very crude and are fire burnt; Fig. 17 from Commerton is more advanced in finish, and is also of a dark clay; Fig. 18 (Garpit) is of much the same material, so far as I can make out, as the material of Dr. Blair's urn. Fig. 16, also from Garpit, is found to be made up of a different material and has a clean terra-cotta coloured finish.

Many specimens of mediæval and modern pottery have been picked up and are in the Wilson Collection. In Dundee Museum there is in Dr. Blair's Collection, the upper part of a green glaze jug like those of the Middle Ages period.

Hammer Stones.—There are numerous examples of hammer stones, rubbers, or crushers of varied material in the collection, and these are to be found all over the moor. The Museum has also been indebted to Mr. A. Speedie of Kinshaldie, who has given several examples found on his ground. They are all naturally rounded or oval stones such as illustrated by Figs. 20 to 23, and the ends are abraded as by use. Figs. 20 and 21 (of quartz) are from Garpit and 23 from Kinshaldie. Fig. 22 was obtained in Tayport itself, and is granitic; it may have been used as a sinker or it may have been hung up inside the door of a stable and used as a witch charm.

Flints found in the district range in colour from dark brown, yellow, to gray, showing that these were probably brought into it from other localities. Owing to the large number of cores and flakes which have been found, the observer is drawn to the conclusion that in former times it was possible the completed article may have been made from raw flint brought into this area. What might be termed scrapers, such as Fig. 24 (Commerton) are frequently found; these may have been used as a "Strike-a-Light," as a similar specimen is figured under this name by W. Boyd Dawkin in his "Early Man in Britain."

Arrow Heads of various shapes and colour are met with, examples such as Fig. 25 (Garpit) with centre and long side prongs are found. Fig. 26 (Commerton) is unpronged and is rounded at the top with the flaking all round its edge. Fig. 26 (Commerton) represents a type which is relatively thicker in ratio to its length than the other types and has only one side prong, the other side either having been broken off or never having been made for some reason. A most unusual type is that figured No. 32, which is of a dark yellow colour, some of a similar type are figured in Evans "Ancient Stone Implements of Great Britain," page 306. Our specimen, like Evans, has a remarkably fine polish on the edge, and on the side away from the edge the flint is blunt and thick. These were probably used for the scraping of skins.

As this goes to the printers, the P. S. A. of S., Vol. 62, has come to hand. In it two similar flints are figured on p. 172; these were obtained at Duns, Berwickshire.

It might be worth mentioning that the flints in the Museum collection here differ in colour according to whether these have been found on the right or left bank of the Tay. The flints from the right bank, on a line through Ardoch to Durder's Ford above Scone, are of a reddish-yellow colour, while those taken from the land on the opposite side, via Mugdrum, Errol, north to Durder's Ford, are grey or black, and at Durder's Ford, on both sides of the river, the two colours are found; this suggests that in the early days this ford was the meeting place of two separate trade routes.

Jet.—The ornaments of jet Mr. Wilson collected mainly on the lands of Garpit. There are isolated specimens from Shanwell, Commerton, some on Morton, and there are a few small pieces in Dr. Blair's Collection. Fig. 31 shows a finely finished half of an armlet about ½-inch in thickness, found at Garpit. What might be a large bead ornament or might have been a whorl is shown as Fig. 30, and this was found at Shanwell. Pieces of lignite are also found, and Figs. 28 and 29 are rather interesting, both pieces were obtained at Garpit, and indicate that some ornament has been in the making from the raw lump during earlier times; it shows how from one piece of material early man had advanced and was able to make more than one ornament from the piece, as in Fig. 29 it shows how No. 28 has been cut at an oblique angle from the lump, probably with the idea of, if possible, making an armlet and having the central portion to make some other ornament from.

Stone Axes.—Figs. 33, 34, 35 represent all the polished stone axes in Mr. Wilson's collection. These are interesting, as Mr. Hutchison in the paper referred to makes the statement that "whereas hammer stones are numerous, the stone implement known as a celt is almost unknown on the Muir, only one, so far as I know, having been discovered." All of the three specimens are from Garpit, near where that represented by Fig. 33, which is small and of a dark green colour, a very fine grey flint pronged arrow head was also obtained. Fig. 34 shows a light coloured stone axe which is an inch thick. On this there has been a long polished edge, which at a later date has had a new edge ground to it at a different angle of grinding. No. 35 is a green blue colour, very much weathered and scored.

Miscellaneous Articles.—Figs. 36 to 39 and 41 to 44 represent bronzes found over the whole of Tentsmuir. Whether there has ever been a bronze pin factory or not will in all likelihood never be proved, but pins such as Fig. 36 have been found in great abundance by various collectors. The other figures speak for themselves, but Fig. 44 looks as if it had belonged to a more recent date, being of a fine mixed alloy and well polished. Numerous whorls are also found, some of them very crude, others again ornamented, so that when spinning round they would show fine radiations as the angle of light was reflected from them. Figs. 45 to 53 are typical of a large number in Mr. Wilson's collection. Fig. 58 is rather a peculiar object, reminding one of an Egyptian specimen, and is of baked red clay, and its shape as if it were to represent some animal, there being two square holes where something to represent ears of an animal might have been inserted. Figs. 59, 60, and 61 are broken pipes, some of those found on the moor are typical of the well-known fairy pipe, undoubtedly Fig. 60 is that of a broken churchwarden pipe. In Dundee I noticed that in Dr. Blair's collection there were pipes of both these types. The origin of the pipes may have been from different localities, as when I placed some of these from the Wilson Collection under the mercury vapour lamp different shades of a greenish colour were reflected back, except in one of the pipes, which almost reflected back its natural colour. This suggests that the clay of which the pipes were made may have come from different localities.

In conclusion, the examination of this area leads one to conjecture that Tentsmuir has been inhabited from prehistoric times, and that the people have been somewhat like the sands of Abertay itself, constantly changing. In the appendix by Mr. Shand to the article by Mr. Hutchison, referred to above, and also in a paper by the Rev. Robert Paul to the P. S. A. of S., Vol. 39, references are made to the kitchen middens of Tentsmuir. Therein are found shells and animal bones, principally ox and sheep, but no evidence of any human artifacts except pottery. Mr. Shand and Mr. Rollo together collected some of these in 1906 and they are in our collection here. A representative collection is illustrated by Plate 46. Might I venture to make the suggestion that these supposed kitchen middens may only have been the result of the farmers in the locality collecting the kelp or seaweed and carting it to that locality where the shell mounds have been found, allowing it to lie and rot in bings, and then scattering it as manure over their fields. During the time it lay in the heap, the sand would naturally be blown, forming a ridge all round, thus the beginnings of a sand mound. It is interesting that in Mr. Shand's collection we find there are pieces of charred vegetable matter, which shows that probably the seaweed was sometimes burnt before using for manurial purposes; the shells and bones we have would, being heavier than the rotted manure, work their way to the bottom, and thus be left when the rotted heap was distributed over the farm fields. My observations of the area tend to confirm my belief that the various articles which have been found on Tentsmuir, even those of early times, are of a period after commerce with the Continent had been well established. Many other of the specimens which are found are of times nearer to our own; in all likelihood these have been left by the people to whom Tentsmuir may have provided a safe place to carry on their business during smuggling days or by beachcombers salving the wreckage of the seas.

XXXIII.—*Museum Notes.*

By John Ritchie, F.R.A.I.

(Read March 9, 1928.)

The following notes of local antiquarian specimens the Museum has recently received might be of interest:—

A Bronze Key (Pl. 44, Fig. 40), found by Master Tom Carling on the right bank of the Tay below where the Almond flows in. I rather suspect it may be Roman, and may have been washed down from the site of Bertha. The same boy found and gave to the Museum a Spindle Whorl he obtained half-way up Kinnoull Hill; another whorl found at the same place was also given.

I recently purchased for the Museum a geological collection. In it I found a small box containing fragments of unglazed pottery, charcoal, bones, and seeds. An old label with it states:—"Found in 1854 at Blairdrummond by H. H. D."

A large light grey flint scraper, presented by Mr Wilson, who found it in the field at Perth Prison after this year's crop of sugar beet had been lifted.

The horn core and portion of a skull of Bos Primigenius, found at Mugdrum by Mr. C. K. S. Wedderburn, and presented to the Museum. The core was projecting out of the water, and on taking hold of it to moor his boat, he pulled it up. Dr. James Ritchie, to whom I submitted the specimen, writes:— "I think it is undoubtedly the core of the right horn of the extinct urus, **Bos Primigenius.** In shape and surface characters it agrees with the horn core of that species, and the flatness of the frontal bone and straightness of the lateral frontal margin are also characters found in the extinct species. Before it was broken, this horn core must have been 20 or 21 inches long, and the horn itself, I should think, must have exceeded two feet. The diameter at the base must have been approximately 9½ inches. This does not represent a large example of the species, and I think it might be concluded that it was a young bull or a cow. It is obvious from the specimen itself that it must have been lying, partially imbedded in mud, partially exposed to the weather, for a long time, because what was originally the back surfaces as well as the tip are abraided and rounded by friction. I have examined the mud which was contained in the cavities of the horns, and cannot find that it gives any help to a recognition of the antiquity of the horns, since the shells it contains are specimens of Hydrobia sinilis, which is probably common enough in the mud of the pond at the present time. There are some other features of interest about the horn."

Rev. D. R. Williamson, of Tomperran, Comrie, among other things presented, gave a dark stone axe, found in moss about four feet below the surface of the West End Meadow, Crieff.

By the courtesy of Mrs. Bernard, Dunsinnan House, I am enabled to show a stone axe found in 1907 by Mr A. Robertson in the Collace Burn. This axe is, I am certain, not Scottish, as it has all the appearance of a Maori axe, both in the texture of the stone and in the manner of its edge polish. We also have from Mrs. Bernard a bronze axe (Pl. 45, Fig. 56). It is of a primitive form, and was found among stones gathered off a field on the farm of Redford, Wolfhill, by J. Weir in 1912.

A bronze fibula of unique design (Pl. 45, Fig. 57) was found by the late Mr William Roy at Cultmalundie, when he resided there. Its design is in the form of a dog, and there are three diagonal lines across its body; both sides are reproduced.

Two plaid brooches with ornamentation are shown at Plate 45, Figs. 54 and 55. These were found built into the walls of an old house which was being demolished at Newton Bridge (Sma' Glen) in 1923, and presented by Mr. J. Nairn Campbell.

PLATE 35. Sandwich Terns. A general view of the colony of approximately 150 pairs present in 1923.

PLATE 36. Roseate Tern. The female returns to the nest.

Roseate Tern. Female on nest, showing streamer feathers of the tail raised above the body.

PLATE 37.

Dunlin. Female standing over nest prior to settling thereon, but showing signs of suspicion and uncertainty due to the presence of the hiding tent. PLATE 38.

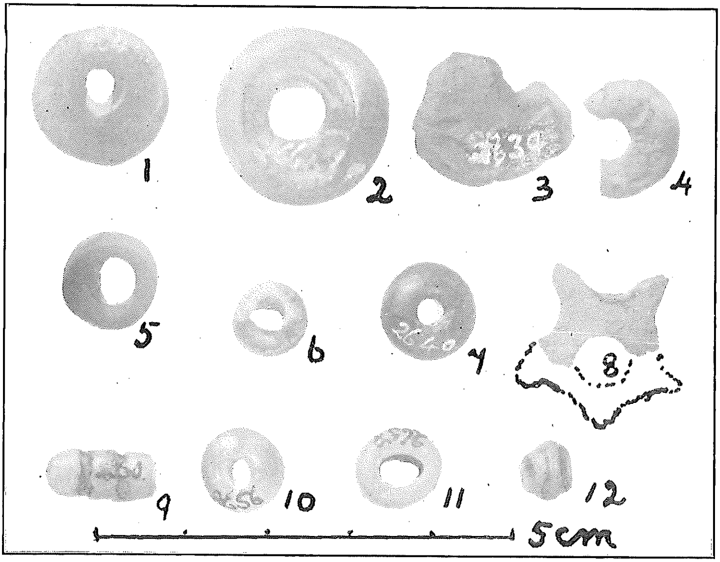


PLATE 39. Beads.

PLATE 40. Dr. Blair's Urn.

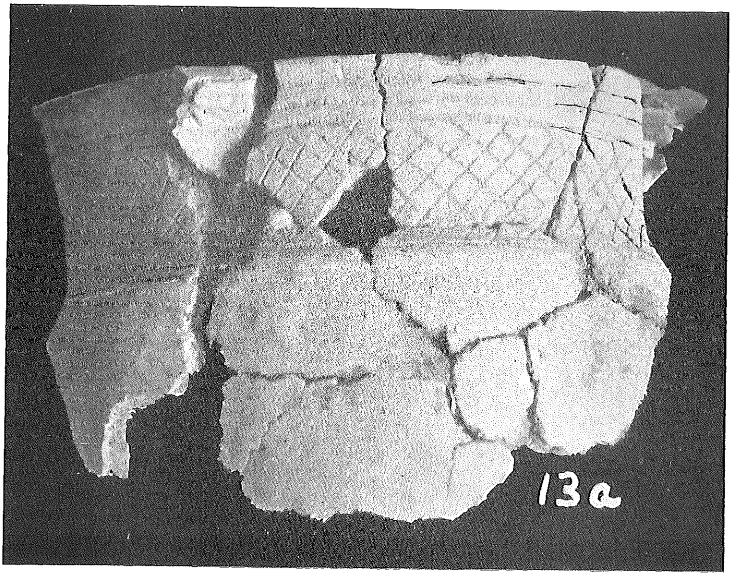


PLATE 41. Tentsmuir Urn.

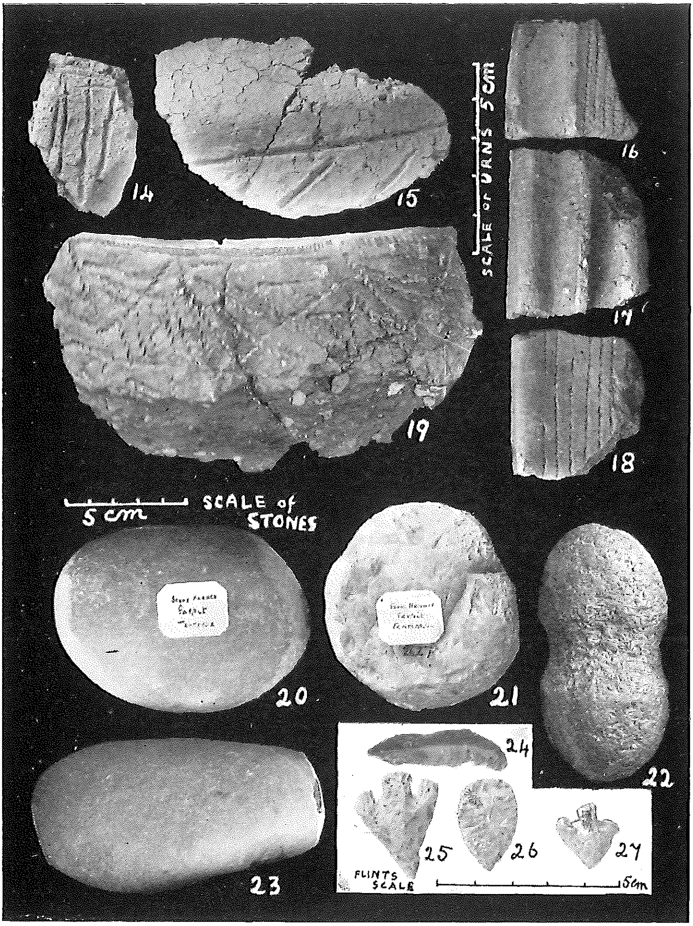


PLATE 42. Urn Fragments, Hammer Stones and Flints.

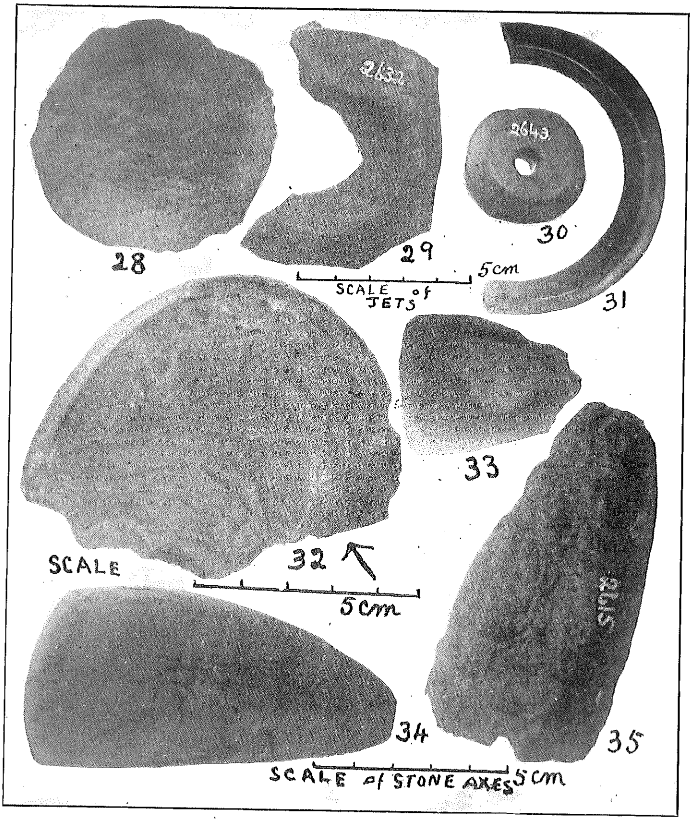


PLATE 43. Jets and Stone Axes.

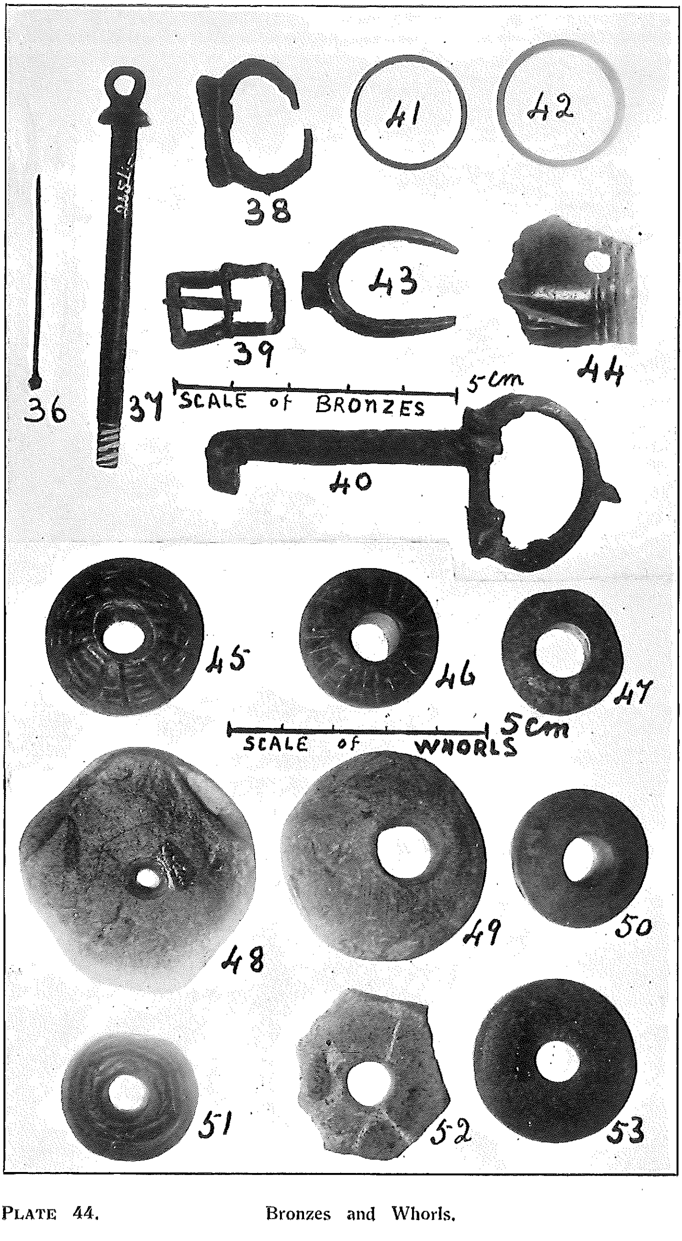


PLATE 44. Bronzes and Whorls.

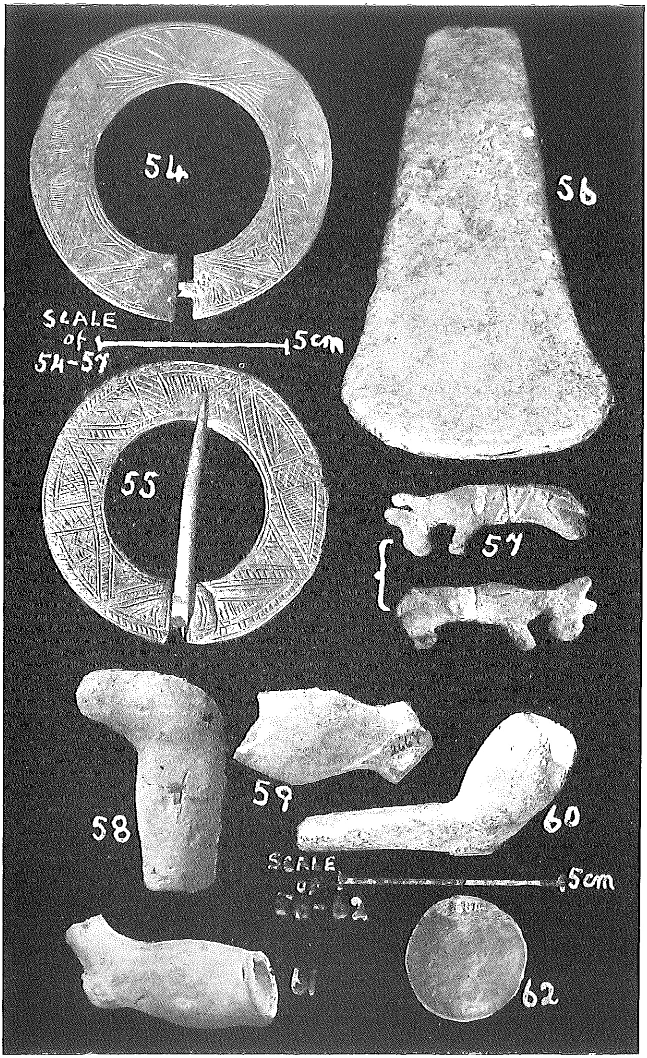


PLATE 45.

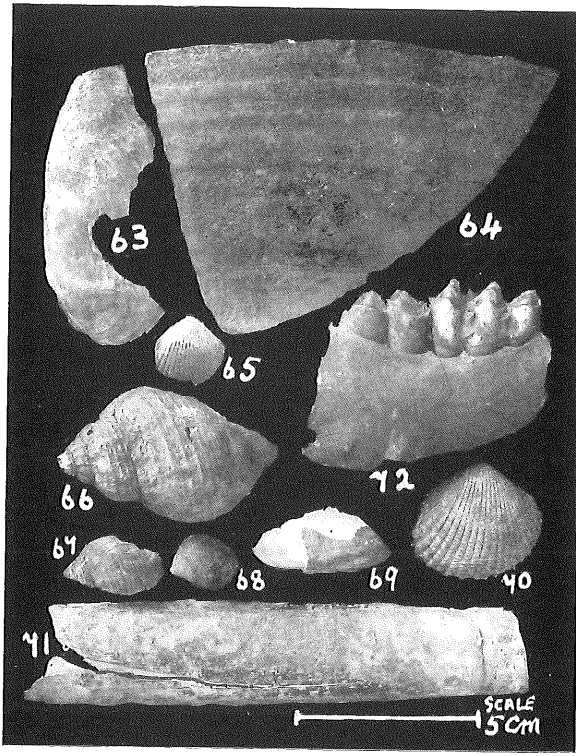


PLATE 46.

XXXIV.—*British Association. Conference of Delegates of Corresponding Societies.*

By Henry Coates, F.S.A. Scot.

(Read January 11, 1929).

I had the pleasure of attending the Conference at Glasgow as your Delegate on Tuesday, 11th September last.

The Chairman was Dr. Vaughan Cornish, and the subject of discussion was "The Scenery of the Lake District." The Chairman, in his opening remarks, recalled the fact that Wordsworth had claimed that the scenery of the Lake District combined the finest features of the scenery of England, Scotland and Wales. Wordsworth also maintained that the rugged native Pines of the region harmonised perfectly with the character of the scenery, whereas the recently introduced Larches, with their softer outline, and more feathery foliage, were unsuited to their surroundings. The same, I have always felt, holds true in regard to our Scottish Highlands.

The Chairman's opening address was followed by a most suggestive Paper by one who is well known to the members of this Society, and who, indeed, is one of our Corresponding Members, namely, Dr. H. R. Mill, of London. His subject was "The Physical Geography of the Lake District," a subject on which he is perhaps better qualified to speak than any other living Geographer, as he carried out the very exhaustive survey of the English Lakes a number of years ago.

He described the Radial Distribution of the Lakes, due to their Geological origin from a central mountain core. The whole of the Lake-valleys stretch out from a common centre, like the spokes of a wheel, dividing the region into twelve roughly wedge-shaped sections, each containing one, or sometimes two, lakes. It is this peculiar structure which gives the Lake District its charming variety of light and shade. He made the configuration plain by holding up the face of his watch, and explaining how each of the Lakes might be supposed to lie in the direction of one of the twelve figures on the dial.

The core of the system consists of very ancient crystalline rocks. During the Cretaceous Period, this core was forced up in the form of a cone, which, in turn, got furrowed into a dozen valleys by the action of rainfall, and other atmospheric conditions, giving rise to the channels in which the Lakes now lie.

Dr. Herdman, of Oxford, followed with a Paper on "Wordsworth's Interpretation of Nature."

Mr. Edward James wound up the Conference with a very practical Paper on "Regional Planning for the English Lake District." He showed how all the Local Authorities should combine to conserve the amenities of the district, and protect it from the too enterprising builder and road maker. The same warnings would apply with equal force to the beauty spots of our own country, and especially of our own county.

The first meeting of the Conference, which took place on Thursday, 6th September, I was not able to attend. The subject of discussion was "The Preservation of the Scenic Beauty of Town and Country," and the speakers included Dr. Vaughan Cornish (Chairman), the Earl of Crawford and Balcarres, Sir John Stirling Maxwell, Professor F. G. Baily, of Edinburgh, and Dr. Hamshaw, of Cambridge.

Among the topics dealt with were "The Smoke Evil in Town and Country," "The Education of the Public in the Appreciation of Scenic Beauty," "Too Ambitious Road Schemes," and "The Preservation of Wild Plants." The last of these is a subject which has more than once been brought before our own Society, particularly in regard to rare species. It is equally necessary, however, to preserve the common plants of field and hedgerow from being ruthlessly uprooted for utilitarian reasons, especially in the making of new roads and the widening and straightening of old ones.

XXXV.—*Nature Notes from Buckie Braes.*

By James Menzies.

(Read January 11, 1929).

Few places round Perth are better known or more frequented, especially by the younger members of the community, than Buckie Braes.

It was well known to many of the older members of this Society, and valued as a hunting-ground for flowering plants, mosses and fungi; and the transformation which it underwent when it passed into the hands of the Corporation some twenty years ago was regarded with dismay. These forebodings were justified, as many species then disappeared never likely to return under the new conditions.

Buckie Braes are interesting Geologically, as they are situated where the volcanic rocks of Craigie Hill lie over against the sandstones of the West, and the glen is largely formed by the denudation of the sandstone. Narrow at the mouth, it gradually widens upwards, and expands at the upper end into a large semicircular bowl-like depression, from which the sandstone has been partially removed. On the West side this removal has been very complete, and the depression is here bounded by a perpendicular wall of rock at least 30 feet in height. A survey of this part leads one to suspect that the removal of the sandstone may have been due to quarrying operations. The Andesite of Craigie Hill forms the whole East side of Buckie Braes. Rising steeply from the central path, it is covered with a thick coating of soil, which carries a luxuriant, but coarse, vegetation.

There is very little of the Andesite exposed anywhere in the glen. It first appears at the margin of the stream, a little above the Rest-house. Then, at the mouth of the stream, it projects as a barrier across the channel, and has been cut through by the action of the water. The bank here, too, is formed of precipitous Andesite, 6 or 8 feet in depth.

Two streams enter from the top at the East side, almost at the same point. The larger one bends abruptly to the West, and, after a tortuous passage, falls over an outcrop of rock, forming what is popularly known as the Falls. From there it pursues a devious course, eventually flowing down close to the left bank. The smaller stream follows at first a fairly straight course, but bends away to the left until it approaches closely at one point to the larger one, with which it merges about a hundred yards further down.

These divagations of the streams below the Falls have resulted in the formation of a large angular space, forming almost an island. This is heaped with sandy tilth and broken sandstone, quite in keeping with the debris from quarrying operations.

The outcrop of rock at the Falls affords a fine example of the disintegration of sandstone by the action of water. Except in the summer months, these rocks are wet from a surface drainage of the higher grounds. Under these conditions, the rocks are corroded, the sandstone breaking away in multitudinous grey particles, which gives the whole place a limey appearance.

The arboreal features of Buckie Braes call for little comment, save in one aspect. The West bank is peopled exclusively with self-sown Ash, interspersed with a few Hawthorns. Many of the Ash trees are little better than saplings, but look as if they should have long since passed this stage. It would be difficult to find anywhere a more crooked assemblage of trees than these Ash trees. The reason for this, I think, is disclosed by a broken bit of the bank which shows that the soil is not very thick, and rests on a mass of loose water-worn stones. This condition is probably characteristic of the whole West bank of the glen. Why trees growing under this condition should be mis-shapen, I must leave others to explain.

The flowering plants are few and unimportant. Immediately below the Falls, a good deal of the orchid, **Orchis mascula,** is in evidence in early summer. On the rocks here masses of the strong-growing mosses, **Hypnum commutatum,** Hedw., and **Hypnum molluscum,** Hedw., are much in evidence in winter and spring. Here also is found a rare Alga, **Rivularia granulifera,** said to be peculiar to those rocks over which water constantly trickles. This plant forms nodules of varying size, and of an olive-brownish colour, in which the green filaments are enclosed. It is of a gelatinous consistency, and a number are often confluent. Another Alga, found on the drier shady rocks, **Trentipholia aurea,** is conspicuous in winter and spring.

The Lichen Flora of Buckie Braes is not an extensive one, but this is atoned for by the rarity of some of the species occurring. Many of the Ash trees bear colonies of **Lecanora pallida,** Schaer., interspersed with plants of **Lecidea parasema,** Ach. A number of the trees near the margin of the stream bear the large greyish-green splatches of **Perthusaria communis,** D.C., very conspicuous in early spring. The common **Parmellia physodes** is only feebly represented on the smooth bark of the trees. The high wall of perpendicular rock already mentioned has, on several occasions, yielded **Thelidium papulare,** Arn., and **Aspicilia calcarea,** Sommers, the latter so persistently eaten by insects that the fruit never matures. Near the Falls, small patches of the pinkish-yellow cups of **Gyalecta cupularis,** Schaer., occur in early spring, and also **Verrucaria mauroides,** Schaer. The stones in the stream (not sandstone) have yielded **Verrucaria aquatilis,** Mudd., **Verrucaria hydrella,** Ach., **Verrucaria submersa,** Schaer., and **Bacidia chloroticula,** A.L.S. The last named had hitherto been only known from Ireland.

I am indebted to Miss Lorrian Smith, of the British Museum, for the identification of some of the above-mentioned lichens, and a number are now in the collection of lichens in the British Museum. Miss Smith has also, in her published census of the localities where the different species are found, recorded these as occurring near Perth.

XXXVI.—*A Day on the Driesh—Glen Clova.*

By James Winter.

(Read January 11, 1929).

Glen Clova is that part of Angus lying 5 miles North of Kirriemuir. The first five miles run almost due North, then, to the head of the Glen, a distance of 13 miles, it lies in a North-West direction. Here the Glen divides—Buchnagairn being to the right and Glen Doll to the left. A right-of-way runs through it to Braemar, while one mile up the former a path goes over the Capel by way of Glenmuick to Ballater. From the comfortable and homely hotel of Clova to climb the Driesh you go up the Glen to Bonhard and cross the Esk at the Black Bridge (1½ miles from the hotel) and pass the farm of Whitehaugh, keeping by the foot of the Bassies till you reach the Hillock burn. This part of the Glen is the narrowest, and the tops of the hills on both sides are very steep. Climbing from the Hillocks is very steep in parts, but steady climbing for forty five minutes brings you to the Hillock Corrie. Here you can choose either of two ways—up the back of the Corrie and then up the ridge to the top, or keeping to the right and ascending the hill to the point between the Hillock and Winter Corrie, where a very fine view down Glen Clova is got. In Hillock Corrie I saw a very fine fox, and, although I have heard them at night on many occasions, it is the first time I have ever got near one. Leaving the point, twenty-five minutes easy walking will bring you to the top of the Driesh, 3105 feet above sea level, and this day (16th July, 1928), I was well rewarded for the trouble of climbing. The day was almost cloudless, with only a slight haze in the far distance. East and West, North and South, the atmosphere was clear, and only seaward could nothing be seen. With compass in hand I noted the following list of Tops :—

North-East to North—**Mount Battock**, 2555 feet (20 miles); **Mount Keen**, 3077 feet (12 miles); to the left the three points of **Benachie** (38 miles); Morvon, 2262 feet (20 miles); Mona Gowan, 2456 feet (22 miles); Carn-a-Bhacam, 2442 feet (22 miles).

North to West.—Loch na gar, 3786 feet (8 miles); Whitemonth, 3553 feet; Ben Avon, 3843 feet (22 miles); Ben Macdhui, 4296 feet (25 miles); Caenlochan—Cairnwell, 3059 feet; Ben Alder, 3757 feet (50 miles); Ben Nevis, 4406 feet (70 miles); Ben-y-gloes.

West to South-West.—Schiehallion, 3547 feet; Ben Chuallaich; Ben-y-Vrackie; Ben Lawers, 3984 feet (45 miles), and Loch Tay range ; Ben More, 3843 feet (60 miles). Nearer at hand—Mount Blair, Craigiebarns and Birnam.

Due South-West.—Ben Ledi, 2857 (60 miles), and a very hazy outline of Ben Lomond (73 miles).

To South and East.—The Ochils, Lomonds, Sidlaws, also Largo Law, were seen.

Only one Loch (Linthrathen) could be seen. The coast line from Montrose Basin to Firth of Tay, also St. Andrews Bay to Fife Ness were visible.

On one occasion I was at the top of Driesh in the evening about 7 o'clock and saw the Bell Rock (42 miles), Isle of May (52 miles), and the Berwick Coast, and counted over twenty steamers, ships, etc., on the sea. If fortunate in the day, the view well repays the exertion of the climbing when you see so much of Scotland at your feet, and then you can sing with Dorothea Ogilvy, of Clova—

"Among the bonny glens, among the towering Bens,
Thy pure inspiring air my bosom thrills ;
Once more in heart a child, I tread thy moorlands wild,
Within the magic circle of thy hills."

XXXVII.—*Fortification or Hillfort at Arnbathie.*

By R. R. Boog Watson.

(Read January 11, 1929).

The site of this Hillfort is given on the O.S. 6-inch map, No. LXXXVI. N.E., as Lawhill. No outline is given, nor the tumulus inside the ramparts. The fort occupies very much the area marked, 700 feet. The site lies due East of the Crossford Road, slightly South of the junction of the Crossford and Balcraig Roads, almost on the line 3° 21′ and 56° 25′ N. and so due West of Evelick camp.

To the North the ground slopes down to the old road to Shian Hill, while the fall to the South, South-east, East and West is fairly abrupt. To the South runs the road to Arnbathie Farm, passing the quarry at Virginhall. To the North-east, in the 600 feet contour, is shown a track keeping below the fortification and passing between same and Arnbathie Loch (note, the loch is not indicated on the 6-inch O.S.), connecting with the track from Boglebee Farm to Arnbathie. The N.E. spur of Murrayshill (N.E. to S.E. line) cuts off all view of the Deuchny hill fort. This spur is shown on the LXXXVI. S.E. map, 6-inch O.S., as sloping from 918 feet and falling to 600 feet above Knowhead.

Roughly, the circumference is some 500 yards. The entrance is from N.E. and runs in along a rock edge towards the East. Along the Western side of this approach are three wall ends. The innermost of these seems to have had a double foundation of stones.

From the entrance across the fortification (N.E. to S.W.) is some 156 yards, passing over the mound or tumulus to the surrounding wall or dyke. The mound is some 27 feet across, and lies on the highest point of the hill. Its outline is not well-defined, but seems to have been made up, at least on the West side. From the entrance about due West, and at some 100 yards, lies what seems to have been a water-hole. It is still very swampy, and rushes grow in it. The foundations for walls seem to have been a double setting of stones.

The North side seems to have been the most heavily fortified, as, across the easy North slope, run three walls. A little below this, there are a lot of placed stones ; this is near the entrance, as at the Deuchny Fort, to prevent a concentrated rush. This placing of stones as " Cheveaux de frise " seems unusual, as in *Proceedings of Scot. Ant.*, Vol. XXI., p. 21-22, special mention is directed to Cadesmuir and Dreva as the only examples.

To the North, beyond the "Cheveaux de frise," two lines cross the hill. These have been levelled, as if for the purpose of stockading, but no sign of a ditch is to be found. To the North-east lies the swampy lochan, beyond the road or track already mentioned. Much of the track is marked by stepping-stones (the 6-inch O.S. shows this as a well-defined road), with the West end stopping suddenly at a dyke (dry stone), which runs down and connects with the Crossford Road (Benchmark 524.6).

The lochan which lies some 500 yards North-east of the entrance to the fort seems always to hold water, being due to a depression in the drift deposit. This seems to drain to the North-west, and in the field is a track for the water supply of Maidenwells (?), a pipe being carried for this purpose. In the lochan there seem to be the remains or traces of a lake dwelling. In 1925, though it was a very dry season, there was always a good supply of water. To the edge was a track of water, clear to the bottom ; farther out was a mass of material, grass and rubbish to judge by sight. To the North corner lies what seems to be the trace of a lacustrine dwelling.

From the lochan there seems to be a discharge North to North-east. The discharge S.W. and S. combine about the farm gate to form the burn running down to Pitroddie Burn. Though many of the heights seem to be volcanic, they do not seem to be a connected whole, but have collected a mass of morainic debris in which the lochan has formed.

These notes have been collected during casual visits, and I regret that, not knowing the landowner, I have been unable to seek permission for closer investigation. I may say that never have I found a worked stone or seen, even in a rabbit scrape, a trace of flint.

XXXVIII.—*Hydro-Electric Power.*

Presidential Address.

By William Malloch, B.Sc.

(Read March 8, 1929).

The subject of my address to-night has been in recent years one of the most absorbing tasks of modern engineers and at the same time a source of much uneasiness to those communities within whose boundaries vast hydro-electric undertakings are either in progress or in contemplation. To the ordinary man in the street the harnessing of immense sources of potential power, presently running to waste in the form of floods, seems to be a matter taken for granted. To him the wonder is not that Schemes should be contemplated, but that so few are put into operation. The very name Hydro-electric conveys to him an impression of something wonderful, something uncanny and perhaps something for nothing. He conjures up visions of all the miniature Niagaras he has seen and thinks of the boon these would confer on the country if developed. We read glowing accounts of the "White Coal" of the Highlands, but few details are supplied as to how it is to be mined. We hear of the reactionary spirit of the Highlander in opposing its utilisation, but we are told little of his reasons for opposition. Perhaps we may be excused if we hold that nothing should be permitted to delay or obstruct the Undertakings which have been proposed and for which Parliamentary Powers are being sought. I shall endeavour to discuss briefly some of the various considerations which affect these proposals and to give you some information on a vexed question.

Nature of Hydro-electric Power.

At the outset let me at once remove the source of the mystery from the minds of those who are unfamiliar with the term "Hydro-Electric Power." There is nothing wonderful, nothing magical, and nothing unusual in the term. We in Perth have been long accustomed to the use of water power. Our Town's Lade has given for centuries a valuable source of Water Power for the

City Mills and the Bleach Works of Huntingtower. Every little mill dam driving a farm threshing mill, saw mill, or corn mill, is a clear-cut example of the development of water power on a miniature scale. If we replace the mill wheel by a turbine, which is really a highly developed type of mill wheel, and also replace the mill machinery by a dynamo, we have at once an up-to-date hydro-electric plant.

Just as the size of the mill wheel, multiplied by the amount of water which it can usefully pass, is a measure of its capacity, usually denoted in terms of Horse Power, so also is the capacity of a hydro-electric station measured by the product of the height of the Fall or "Head" by the volume of water passing through the turbines. Instead of expressing the result in terms of Horse Power, it is usual to employ the electrical term "Kilowatt," which is equivalent to one and one-third horse power. The analogy may be extended. In many cases the small streams upon which mill wheels are situated do not provide sufficient flow of water during dry periods. The miller, be he saw miller, flour miller, or mill wright, resorts in these cases to the construction of a mill dam or reservoir to tide him over drought. Further, in order to obtain sufficient fall or head to drive his wheel, he constructs a lade leading the water from the mill dam to the mill. This at once gives him full control of the water, sufficient height for power, and obviates any risk of damage during floods or frost.

Similarly the hydro-electric engineer designs vast reservoirs, large aqueducts, diversion of rivers and streams, and other subsidiary works, to impound, divert, control and regulate the water of many square miles of territory, situated, for the most part, in the headwaters and lochs of our main river systems. The ideal conditions are: a large catchment area situated at a high altitude, plentifully supplied with large lochs or suitable sites for reservoirs, a heavy rainfall of fairly even distribution throughout the year, and a convenient site for a Power Station at no great distance from the reservoir. The aluminium works at Kinlochleven may be cited as an ideal scheme. Many such sites are not uncommon in Sweden and Switzerland where the effect of glaciers tends to equalise the flow of water during early summer periods when the rainfall may be at a minimum. It is apparent, therefore, that the preliminary survey for an important Hydro-electric Scheme must include the collection of all available statistics of river flow, weather, rainfall and other meteorological records.

Debt due to Original Workers.

I do not think adequate recognition has been made of the invaluable services rendered by unobtrusive investigators in the field of natural science. Without their preliminary and voluntary work few of the Hydro-electric Schemes now proposed or in course of construction could have been successfully brought to their present stage. Much of the information necessary for formulating Schemes has been obtained from local sources, generally from searchers after knowledge and nature lovers who have been content to pursue scientific studies for the love of investigation and for no other purpose. Throughout the country there are many unofficial meteorological stations, amassing useful information of rainfall statistics, conditions of weather, height of rivers and other observations. To these patient, unremitting and unpaid workers, the hydro-electric engineer must ever be indebted. Nor must we omit to mention the valuable data collected by the geologist and by the gallant force of workers so ably led by Sir John Murray and Laurence Pullar. The work of the Bathymetrical Survey, conducted without Government assistance, indeed after considerable difficulty with Government Departments, has added enormously to the knowledge of the Hydro-electric Engineer, and has enabled the storage capacity of the Scottish Lochs to be readily ascertained and estimated.

Guiding Principles.

In 1921 the Water Power Resources Committee issued its final Report on the Development of Water Power within the United Kingdom, and the Schemes now being undertaken are based on the details embodied in this Report. Certain principles were formulated to which strict attention has to be paid by the Promoters of Hydro-electric Schemes. Since further reference will be made to some of these principles, I quote the following :—

(1) Adequate protection to be given to interests detrimentally affected.
(2) Domestic and Sanitary requirements to take precedence over power requirements.
(3) Good grounds must be given for taking water out of its natural watershed.
(4) Water Power Schemes should be economically sound.

Of the above four principles the first and last are most likely to occasion greatest difficulty to the Hydro-electric Engineer. The provision for precedence to be given to domestic and sanitary requirements, although a very necessary safeguard, is, as a rule, not a serious matter, since the amount of water required for a water supply, even by a large community, is generally a mere fractional part of the volume required for generating purposes on a large scale. In some instances, however, the sanitary requirements cannot be ignored. Without a sufficient flow to cleanse it, the River Tay at our door might soon become offensive and the pollution so undiluted as to prohibit the use of the river as a source of water supply.

Obviously it would be iniquitous to permit unconditionally wholesale abstraction from one watershed into another, as the practice would inflict hardship upon the inhabitants of the area robbed of their natural rights. The grounds for doing so must therefore be strong, and only the possibility of generating power cheaply, and the creation of important industries would over-rule this principle. The real problem, therefore, is to formulate a scheme economically sound and affording adequate protection to the interests detrimentally affected.

Source of Power.

Since the source of all Hydro-electric Schemes is water, preferably in abundance, attention is at once directed to the great rain-bearing areas near to our western sea-board. Like the psalmist, the engineer looks to the hills in his time of need. To the immediate east of the western mountain ranges he finds long valleys and extensive plains situated at high levels, and the source of our chief river systems. The area has the unenviable reputation of being the wettest in Scotland, but there is one at least, the engineer, who looks upon the excessive rainfall as being a gift from the gods. But even here there are initial difficulties. The shortest, and, for the engineer, the most economical course, is to tunnel through to the conveniently situated west coast, and to erect his Power Station at sea level. This has been done at Fort William, in the Lochaber Scheme, now well under way, and is also proposed in the West Highland Scheme immediately to the north. This at once violates the third principle laid down by the Water Power Resources Committee, and therefore must needs be carefully examined.

The first Grampian Electricity Supply Scheme, situated for the greater part in our own county, will abstract water from the Spey watershed, augmenting the ultimate flow in the Tay. The second Grampian Supply Scheme, for which powers are now being sought, apart from minor works adding to the flow in the River Beauly by taking a small flow from the west coast, will retain the ultimate flow within its natural watershed. The last-named three Schemes have a common difficulty, the Power Stations are situated in districts remote from industrial centres, and, since the nearest Burghs, such as Perth, Aberdeen, Dundee and Inverness, have electric plants installed, the Capital Costs of the Schemes will be largely increased by the additional expense of running heavy transmission cables to the large consumers in the south. The alternative is to attract industries to the seat of power, but this can only be done if a supply of very cheap power can be given at a rate well under that in the south from competing steam and hydro-electric plant.

Financial Aspect.

The costs of construction may therefore be the ultimate factor for success or failure in these Schemes. Since the capital cost of a Hydro-electric Scheme becomes a permanent burden on the Undertaking, the initial over-head charges to cover interest on capital expenditure are onerous, and to a large extent govern the price to the consumer. The running charges are light, and do not appreciably influence the price. In the case of steam plants, the conditions are exactly opposite. Overhead charges are comparatively low, since capital expenditure on the power stations is not unduly high, somewhere in the neighbourhood of one-tenth of hydro-electric stations, but running costs increase with the demand for power. In each case the Plant must be fully capable of taking the maximum load, which usually occurs between four and five o'clock for three or four months in the winter. During the summer months, lighting is at a minimum, and electric plants must then depend upon power consumption from large works for their source of revenue. If the power is continuously required night and day throughout the twenty-four hours, a condition of maximum load is practically reached. If, on the other hand, power is required for a few hours daily, the generating sets will be idle or nearly so. This intermittent use of power is termed the "Load Factor," and has a vital influence upon the success or failure of hydro-electric schemes.

Load Factor.

Since the point is of greatest importance, perhaps I may be allowed to give an every-day illustration of a load factor. The Perth Corporation Omnibuses have a varying load factor. During rush hours and meal hours they are filled, shall we say, to overflowing. At other and quieter hours they are running practically empty. The costs of running empty, however, are not less than those when running full. Standing charges, interest on capital expenditure have to be paid. The revenue under full loading must therefore pay for the loss during light loading. Further, during summer months the patrons of the buses are more inclined to walk to and from business, and the daily average load on this account is probably lower than in winter. It is evident, therefore, that if every bus carried a full complement on each journey, the overhead charges would be very low per running mile, and possibly, instead of proposing increases in fares, the Corporation might well afford to introduce halfpenny stages. Such a condition would nearly represent a load factor of 100%.

Hydro-electric Undertakings working at a load factor of 100% would certainly be economic propositions if the capital costs were not extravagant. The difficulty, however, is to reach or to approach this ideal. Should the Load Factor drop to the usual one met with in ordinary practice, between 30 and 40%, steam plants are likely to be more economical.

SCHEMES PROPOSED.

If we examine the area of supply sought by the Promoters of the Grampian and West Highland Schemes, we find that it would be unable to afford a high Load Factor, nor would it absorb more than a fractional part of the Power generated. It would appear, therefore, that the real intention of the Promoters is not primarily to supply Grampian areas, but to sell in bulk to large consumers in the south. The electricity will be transmitted by very high tension cables, something of the order of 132,000 volts, and although villages and small towns may be situated on the lines of supply, the cost of erecting transforming stations will be prohibitive. It is possible that a low tension cable may be laid through the more populous districts, but the price of the current is unlikely to fall much, if any, below the maximum, on account of the long lengths of unprofitable cable. It would appear, therefore, that the Highlands are likely to constitute the Power House of Central Scotland, and that no material advantage will accrue to the large areas from which power is abstracted. Perthshire and Inverness-shire will be the clocking hens of industrial development in the south.

EMPLOYMENT.

In these dark days of rife unemployment, the construction of works is certain to afford temporary relief. Each Undertaking is probably capable of absorbing a thousand or more men. Provided the material is drawn from the right quarter, i.e., from the ranks of genuine Scottish unemployed, and not imported labour from Ireland of undesirable character, the relief is welcome though it be but for a year or two. Irish labour, on the other hand, is as unwelcome as it is unwholesome for Scotland, and no Undertaking should be permissible unless at least 90% of the labour is of Scottish origin. Further, the practice of installing canteens and stores supplied from distant centres instead of from local sources should be discouraged. During construction, tourists, as a rule, choose other scenes than those occupied by labour camps for their sojourns, and the loss in revenue to a holiday centre should be made good by marketing largely to the labour employed.

On completion, the labour required for operating the Power Stations is negligible and of a skilled nature. Each Undertaking is capable of absorbing something less than fifty skilled men. Industries must be attracted by cheap power, sites for factories, housing, and sea or rail transport must be available. The Highlands, by their remoteness and inaccessibility, do not appear to offer such advantages, and it is feared that these districts, at any rate, will not benefit by the Undertakings. If, however, Power can be produced and supplied at a low cost, even though it is consumed in large bulk in Central industrial Scotland, the Undertakings may be worthy of encouragement.

Fears of Injury.

Thus far we have considered the effect of the Schemes from the purely utilitarian point of view. We have asked and attempted to answer the question, "Will it pay?" We have partly answered the question, "Will it benefit the population in the neighbourhood?" and we now ask the question, "Will it seriously harm the appearance of the locality?"

Our answer to the third question is a part answer to the second, since loss in amenity to a tourist district must be accompanied by loss to the population.

The Undertakings will involve the construction of high concrete dams on lochs and rivers, causing submergence of large areas of valuable grazings and river valleys. Aqueducts in open cut or in concrete channels will be constructed in the hill sides, and accommodation roads and camps will be built throughout the area involved. Blasting, disturbance and interference will be inevitable, and generally the district during construction will be untenable for visitors if not for the inhabitants. The itinerant navvy of low-grade class, perpetually shifting and changing from camp to camp, for the Irishman loves a change for change's sake, will be a source of continual nuisance, and an unwelcome means of steady employment to the rural police force. These effects for the most part will be of a temporary nature, but there are other and more important changes of a permanent character.

Permanent Damage.

The Highlands depend largely upon their unrivalled scenic and sporting attractions for their source of revenue. It is important, therefore, to examine carefully the effect of the proposals upon these unique assets. The Reservoirs will fluctuate in level to an unprecedented extent, and their exposed margins in summer will be unsightly and unwholesome. Rivers will be deprived of their flow of water, and magnificent glens, famed far and wide, will be converted into dry, stone channels. Our greatest attraction, the many noted Falls, such as Struan, Bruar, Dunalastair, Killiechonan and Tarf in Perthshire; Farrar, Monar, Cannich, Affaric, Kilmorack, Loyne and Moriston in Inverness-shire; and the great Falls of Glomach in Ross-shire will either no longer exist or be so attenuated as to lose their character. The Hillsides and Valleys will be disfigured by ugly spoil heaps, which even the lichens will avoid, and by raw scars, concrete aqueducts, bridges, buildings and dams. The rich green meadows at the sides of lochs and in the flat valleys will be converted alternately into flooded marshes or desolate wastes. These are no mere idle fears, but the inevitable result of hydro-electric development.

Sporting Estates.

Unquestionably considerable injury of a permanent character will be caused to the many valuable sporting properties within the area affected by these Undertakings. This the Promoters realise and are prepared to negotiate terms with the Proprietors. The sources of injury are many, but perhaps the following may suffice for our purpose.

1. By the wholesale abstraction, control and diversion, of the flow of water, famous salmon rivers, such as the Tummel, Garry, Ness and Beauly, may be permanently impaired, if not ruined. When it is considered that the head-waters of our river systems form the most valuable breeding grounds upon which the productivity of the Fishings—River and Sea-Coast—largely depend, it will be recognised that the loss of spawning grounds is bound to have a far-reaching effect. In many cases the net fishermen and river ghillies are also crofters, and the loss of a lucrative job during the summer might well lead to abandonment of the crofts, thus adding a dismal page to the record of depopulation of the Highlands.
2. By the submergence of the valuable grazings round lochs and in river valleys the sole wintering grounds of sheep and deer will be destroyed, and the stock may wander into neighbouring forests, perhaps never to return.
3. Valuable buildings, roads, bridges, walks, fences, and policies will be submerged, and there will be considerable severance of properties, thus increasing the cost of maintaining the estates.
4. There will be considerable disturbance to deer forests and grouse moors during construction, especially by blasting, and by men wandering over the hillsides to and from their jobs.
5. Poaching is likely to be rife and, although watchers may be provided, it will be impossible to keep this wholly in check.
6. There will be ever present the risk, be it ever so slight, of dams failing. In recent years several such instances have been known, accompanied by serious loss of life and damage to property.

Loss to Rating Authorities.

Whilst the promise of creating new industries has been held out to County Councils, the Promoters can give no guarantee that new industries will come or even be attracted to the Districts. If the Undertakings proceed, the County Councils and Rating Authorities will be faced by a serious depreciation in Rating value of the Properties adversely affected. In some instances the Proprietors may settle for cash payments for which there can be no entry in the valuation roll. There will be increased expenditure on public services, such as police, public health, education and roads during construction.

In return for these losses, the Undertakings will be rated on completion. The Clauses embodied in the present Bills, however, are so far-reaching that the revenue, if any, obtained by the County Council will not be of any moment, and will certainly fall far short of the amount required to compensate the loss in rating caused by depreciation of properties. Further, the Promoters seek powers for absolute monopoly of supply over many counties at almost prohibitive charges. There is little likelihood of reduction in price of current, since, as already stated, the overhead charges are permanent, and any future improvement in hydro-electric machinery and transmission will not reflect appreciably on the price to the consumer.

It will be obvious, therefore, that every Scheme must be minutely scrutinised before being authorised. No Scheme involving hardship and loss to a community should be passed unless there are obvious and certain advantages of a very material nature to be derived.