JOURNAL

OF THE

ROYAL MICROSCOPICAL SOCIETY;

CONTAINING ITS TRANSACTIONS AND PROCEEDINGS,

AND A SUMMARY OF CURRENT RESEARCHES RELATING TO

ZOOLOGY AND BOTANY

(principally Invertebrata and Cryptogamia),

MICROSCOPY, &c.

Edited by

F. JEFFREY BELL, M.A.,

One of the Secretaries of the Society,
and Professor of Comparative Anatomy and Zoology in King's College;

WITH THE ASSISTANCE OF THE PUBLICATION COMMITTEE AND

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FOR THE YEAR

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Part 1.

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THE

Royal Microscopical Society.

(Established in 1839. Incorporated by Royal Charter in 1866.)

The Society was established for the promotion of Microscopical and Biological Science by the communication, discussion and publication of observations and discoveries relating to (1) improvements in the construction and mode of application of the Microscope, or (2) Biological or other subjects of Microscopical Research.

It consists of Ordinary, Honorary, and Ex-officio Fellows, without distinction of sex.

Ordinary Fellows are elected on a Certificate of Recommendation, signed by three Ordinary Fellows, setting forth the names, residence, and description of the Candidate, of whom the first proposer must have personal knowledge. The Certificate is read at two General Meetings, and the Candidate balloted for at the second Meeting.

The Admission Fee is £2 2*s*., and the Annual Subscription £2 2*s*., payable on election, and subsequently in advance on 1st January annually, but future payments may be compounded for at any time for £31 10*s*. Fellows elected at a meeting subsequent to that in February are only called upon for a proportionate part of the first year's subscription, and Fellows permanently residing abroad are exempt from one-fourth of the annual subscription.

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The Council, in whom the management of the property and affairs of the Society is vested, is elected annually, and is composed of the President, four Vice-Presidents, Treasurer, two Secretaries, and twelve other Ordinary Fellows.

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In each Session two additional evenings are devoted to the exhibition of Instruments, Apparatus, and Objects of novelty or interest relating to the Microscope or the subjects of Microscopical Research.

The Journal, containing the Transactions and Proceedings of the Society, and a Summary of Current Researches relating to Zoology and Botany (principally Invertebrata and Cryptogamia), Microscopy, &c., is published bi-monthly, and is forwarded post-free to all Ordinary and Ex-officio Fellows residing in countries within the Postal Union.

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* In order to make the classification complete, (1) the papers printed in the 'Transactions,' (2) the abstracts of the 'Bibliography,' and (3) the notes printed in the 'Proceedings' are included here.

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(6) Miscellaneous.

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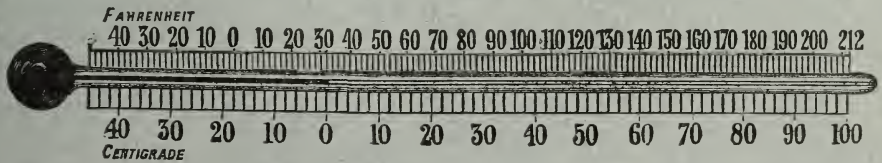
APERTURE TABLE.

Numerical Aperture. ($n \sin u = a$.)	Corresponding Angle ($2u$) for			Limit of Resolving Power, in Lines to an Inch.			Illuminating Power. (a^2.)	Penetrating Power. $\left(\frac{1}{a}\right)$
	Air ($n = 1{\cdot}00$).	*Water* ($n = 1{\cdot}33$).	*Homogeneous Immersion* ($n = 1{\cdot}52$).	White Light. ($\lambda = 0{\cdot}5269\ \mu$, Line E.)	Monochromatic (Blue) Light. ($\lambda = 0{\cdot}4861\ \mu$, Line F.)	Photography. ($\lambda = 0{\cdot}4000\ \mu$, near Line *h*.)		
1·52	..	..	180° 0′	146,543	158,845	193,037	2·310	·658
1·51	..	..	166° 51′	145,579	157,800	191,767	2·280	·662
1·50	..	..	161° 23′	144,615	156,755	190,497	2·250	·667
1·49	..	..	157° 12′	143,651	155,710	189,227	2·220	·671
1·48	..	..	153° 39′	142,687	154,665	187,957	2·190	·676
1·47	..	..	150° 32′	141,723	153,620	186,687	2·161	·680
1·46	..	..	147° 42′	140,759	152,575	185,417	2·132	·685
1·45	..	..	145° 6′	139,795	151,530	184,147	2·103	·690
1·44	..	..	142° 39′	138,830	150,485	182,877	2·074	·694
1·43	..	..	140° 22′	137,866	149,440	181,607	2·045	·699
1·42	..	..	138° 12′	136,902	148,395	180,337	2·016	·704
1·41	..	..	136° 8′	135,938	147,350	179,067	1·988	·709
1·40	..	..	134° 10′	134,974	146,305	177,797	1·960	·714
1·39	..	..	132° 16′	134,010	145,260	176,527	1·932	·719
1·38	..	..	130° 26′	133,046	144,215	175,257	1·904	·725
1·37	..	..	128° 40′	132,082	143,170	173,987	1·877	·729
1·36	..	..	126° 58′	131,118	142,125	172,717	1·850	·735
1·35	..	..	125° 18′	130,154	141,080	171,447	1·823	·741
1·34	..	..	123° 40′	129,189	140,035	170,177	1·796	·746
1·33	..	180° 0′	122° 6′	128,225	138,989	168,907	1·769	·752
1·32	..	165° 56′	120° 33′	127,261	137,944	167,637	1·742	·758
1·30	..	155° 38′	117° 35′	125,333	135,854	165,097	1·690	·769
1·28	..	148° 42′	114° 44′	123,405	133,764	162,557	1·638	·781
1·26	..	142° 39′	111° 59′	121,477	131,674	160,017	1·588	·794
1·24	..	137° 36′	109° 20′	119,548	129,584	157,477	1·538	·806
1·22	..	133° 4′	106° 45′	117,620	127,494	154,937	1·488	·820
1·20	..	128° 55′	104° 15′	115,692	125,404	152,397	1·440	·833
1·18	..	125° 3′	101° 50′	113,764	123,314	149,857	1·392	·847
1·16	..	121° 26′	99° 29′	111,835	121,224	147,317	1·346	·862
1·14	..	118° 0′	97° 11′	109,907	119,134	144,777	1·300	·877
1·12	..	114° 44′	94° 55′	107,979	117,044	142,237	1·254	·893
1·10	..	111° 36′	92° 43′	106,051	114,954	139,698	1·210	·909
1·08	..	108° 36′	90° 34′	104,123	112,864	137,158	1·166	·926
1·06	..	105° 42′	88° 27′	102,195	110,774	134,618	1·124	·943
1·04	..	102° 53′	86° 21′	100,266	108,684	132,078	1·082	·962
1·02	..	100° 10′	84° 18′	98,338	106,593	129,538	1·040	·980
1·00	180° 0′	97° 31′	82° 17′	96,410	104,503	126,998	1·000	1·000
0·98	157° 2′	94° 56′	80° 17′	94,482	102,413	124,458	·960	1·020
0·96	147° 29′	92° 24′	78° 20′	92,554	100,323	121,918	·922	1·042
0·94	140° 6′	89° 56′	76° 24′	90,625	98,233	119,378	·884	1·064
0·92	133° 51′	87° 32′	74° 30′	88,697	96,143	116,838	·846	1·087
0·90	128° 19′	85° 10′	72° 36′	86,769	94,053	114,298	·810	1·111
0·88	123° 17′	82° 51′	70° 44′	84,841	91,963	111,758	·774	1·136
0·86	118° 38′	80° 34′	68° 54′	82,913	89,873	109,218	·740	1·163
0·84	114° 17′	78° 20′	67° 6′	80,984	87,783	106,678	·706	1·190
0·82	110° 10′	76° 8′	65° 18′	79,056	85,693	104,138	·672	1·220
0·80	106° 16′	73° 58′	63° 31′	77,128	83,603	101,598	·640	1·250
0·78	102° 31′	71° 49′	61° 45′	75,200	81,513	99,058	·608	1·282
0·76	98° 56′	69° 42′	60° 0′	73,272	79,423	96,518	·578	1·316
0·74	95° 28′	67° 37′	58° 16′	71,343	77,333	93,979	·548	1·351
0·72	92° 6′	65° 32′	56° 32′	69,415	75,242	91,439	·518	1·389
0·70	88° 51′	63° 31′	54° 50′	67,487	73,152	88,899	·490	1·429
0·68	85° 41′	61° 30′	53° 9′	65,559	71,062	86,359	·462	1·471
0·66	82° 36′	59° 30′	51° 28′	63,631	68,972	83,819	·436	1·515
0·64	79° 36′	57° 31′	49° 48′	61,702	66,882	81,279	·410	1·562
0·62	76° 38′	55° 34′	48° 9′	59,774	64,792	78,739	·384	1·613
0·60	73° 44′	53° 38′	46° 30′	57,846	62,702	76,199	·360	1·667
0·58	70° 54′	51° 42′	44° 51′	55,918	60,612	73,659	·336	1·724
0·56	68° 6′	49° 48′	43° 14′	53,990	58,522	71,119	·314	1·786
0·54	65° 22′	47° 54′	41° 37′	52,061	56,432	68,579	·292	1·852
0·52	62° 40′	46° 2′	40° 0′	50,133	54,342	66,039	·270	1·923
0·50	60° 0′	44° 10′	38° 24′	48,205	52,252	63,499	·250	2·000
0·45	53° 30′	39° 33′	34° 27′	43,385	47,026	57,149	·203	2·222
0·40	47° 9′	35° 0′	30° 31′	38,564	41,801	50,799	·160	2·500
0·35	40° 58′	30° 30′	26° 38′	33,744	36,576	44,449	·123	2·857
0·30	34° 56′	26° 4′	22° 46′	28,923	31,351	38,099	·090	3·333
0·25	28° 58′	21° 40′	18° 56′	24,103	26,126	31,749	·063	4·000
0·20	23° 4′	17° 18′	15° 7′	19,282	20,901	25,400	·040	5·000
0·15	17° 14′	12° 58′	11° 19′	14,462	15,676	19,050	·023	6·667
0·10	11° 29′	8° 38′	7° 34′	9,641	10,450	12,700	·010	10·000
0·05	5° 44′	4° 18′	3° 46′	4,821	5,225	6,350	·003	20·000

COMPARISON OF THE FAHRENHEIT AND CENTIGRADE THERMOMETERS.

Fahr.	Centigr.	Fahr.	Centigr.	Fahr.	Centigr.	Fahr.	Centigr.	Fahr.	Centigr.
°	°	°	°	°	°	°	°	°	°
212	100	158	70	104	40	50	10	- 4	- 20
210·2	99	156·2	69	102·2	39	48·2	9	- 5·8	- 21
210	98·89	156	68·89	102	38·89	48	8·89	- 6	- 21·11
208·4	98	154·4	68	100·4	38	46·4	8	- 7·6	- 22
208	97·78	154	67·78	100	37·78	46	7·78	- 8	- 22·22
206·6	97	152·6	67	98·6	37	44·6	7	- 9·4	- 23
206	96·67	152	66·67	98	36·67	44	6·67	- 10	- 23·33
204·8	96	150·8	66	96·8	36	42·8	6	- 11·2	- 24
204	95·56	150	65·56	96	35·56	42	5·56	- 12	- 24·44
203	95	149	65	95	35	41	5	- 13	- 25
202	94·44	148	64·44	94	34·44	40	4·44	- 14	- 25·56
201·2	94	147·2	64	93·2	34	39·2	4	- 14·8	- 26
200	93·33	146	63·33	92	33·33	38	3·33	- 16	- 26·67
199·4	93	145·4	63	91·4	33	37·4	3	- 16·6	- 27
198	92·22	144	62·22	90	32·22	36	2·22	- 18	- 27·78
197·6	92	143·6	62	89·6	32	35·6	2	- 18·4	- 28
196	91·11	142	61·11	88	31·11	34	1·11	- 20	- 28·89
195·8	91	141·8	61	87·8	31	33·8	1	- 20·2	- 29
194	90	140	60	86	30	32	0	- 22	- 30
192·2	89	138·2	59	84·2	29	30·2	- 1	- 23·8	- 31
192	88·89	138	58·89	84	28·89	30	- 1·11	- 24	- 31·11
190·4	88	136·4	58	82·4	28	28·4	- 2	- 25·6	- 32
190	87·78	136	57·78	82	27·78	28	- 2·22	- 26	- 32·22
188·6	87	134·6	57	80·6	27	26·6	- 3	- 27·4	- 33
188	86·67	134	56·67	80	26·67	26	- 3·33	- 28	- 33·33
186·8	86	132·8	56	78·8	26	24·8	- 4	- 29·2	- 34
186	85·56	132	55·56	78	25·56	24	- 4·44	- 30	- 34·44
185	85	131	55	77	25	23	- 5	- 31	- 35
184	84·44	130	54·44	76	24·44	22	- 5·56	- 32	- 35·56
183·2	84	129·2	54	75·2	24	21·2	- 6	- 32·8	- 36
182	83·33	128	53·33	74	23·33	20	- 6·67	- 34	- 36·67
181·4	83	127·4	53	73·4	23	19·4	- 7	- 34·6	- 37
180	82·22	126	52·22	72	22·22	18	- 7·78	- 36	- 37·78
179·6	82	125·6	52	71·6	22	17·6	- 8	- 36·4	- 38
178	81·11	124	51·11	70	21·11	16	- 8·89	- 38	- 38·89
177·8	81	123·8	51	69·8	21	15·8	- 9	- 38·2	- 39
176	80	122	50	68·2	20	14	- 10	- 40	- 40
174·2	79	120·2	49	66	19	12·2	- 11	- 41·80	- 41
174	78·89	120	48·89	66·4	18·89	12	- 11·11	- 42	- 41·11
172·4	78	118·4	48	64	18	10·4	- 12	- 43·60	- 42
172	77·78	118	47·78	64·6	17·78	10	- 12·22	- 44	- 42·22
170·6	77	116·6	47	62	17	8·6	- 13	- 45·40	- 43
170	76·67	116	46·67	62·8	16·67	8	- 13·33	- 46	- 43·33
168·8	76	114·8	46	60	16	6·8	- 14	- 47·20	- 44
168	75·56	114	45·56	60	15·56	6	- 14·44	- 48	- 44·44
167	75	113	45	59	15	5	- 15	- 49	- 45
166	74·44	112	44·44	58	14·44	4	- 15·56	- 50	- 45·56
165·2	74	111·2	44	57·2	14	3·2	- 16	- 50·80	- 46
164	73·33	110	43·33	56	13·33	2	- 16·67	- 52	- 46·67
163·4	73	109·4	43	55·4	13	1·4	- 17	- 52·60	- 47
162	72·22	108	42·22	54	12·22	0	- 17·78	- 54	- 47·78
161·6	72	107·6	42	53·6	12	- 0·4	- 18	- 54·40	- 48
160	71·11	106	41·11	52	11·11	- 2	- 18·89	- 56	- 48·89
159·8	71	105·8	41	51·8	11	- 2·2	- 19	- 56·20	- 49
								- 58	- 50



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TRANSACTIONS OF THE SOCIETY.

I.—*Some Observations on the Various Forms of Human Spermatozoa.*

By R. L. Maddox, M.D., Hon. F.R.M.S.

(*Read 19th November*, 1890.)

Plate I.

In examining some recent slides of human spermatozoa, prepared in various ways, I was struck with the different appearances some reagents gave, and also by the abnormal forms to be found by careful study. It is for the purpose of noting some of these varieties that I venture to offer a few remarks, trusting they may be of interest.

There is considerable difficulty in so differentiating the parts that form these potent bodies without at the same time too freely disturbing their natural conditions.

The following methods out of many trials have appeared to be the most satisfactory. After diluting the sperm with the normal salt solution 0·75 per cent., it was very lightly smeared on the cover-

EXPLANATION OF PLATE I.

(The figures in the original drawings are variously coloured, but are here tinted to one shade; all except the last two × 3120.)

Fig. *a*.—A fairly normal spermatozoon.
„ *b, c, d*.—With single, double, and treble vacuoles or light spaces.
„ *e*.—The usually dark or denser portion reversed in position.
„ *f*.—Head and filament united by a clear ring.
„ *g*.—An abnormal head.
„ *h*.—The filament embracing the head.
„ *j*.—A spermatozoon seen somewhat obliquely.
„ *k*.—Ditto ditto.
„ *l*.—Head with two constrictions.
„ *m*.—Two heads, both small, to one filament.
„ *n*.—Two heads finally united in one filament.
„ *o*.—Head with two clear spaces, filament tending to a separation.
„ *p*.—Large head, filament tending to divide into three filaments.
„ *q*.—A greatly contorted head.
„ *r*.—Two heads to one filament × 810 } photo.
„ *s*.—Two single heads with each two filaments × 750 }

glass and dried without heat. The material was then covered with a weak solution of the ordinary iodine and potassic iodide solution mixed with rather less than an equal part of a saturated solution of potassic acetate, and the cover mounted in the same, without washing. This gave the organisms a very delicate greenish, or bluish-green, or grey tint, which showed the relations of the plasm in the heads or ovoid bodies very clearly, without, as far as I could judge, displacement, enlargement, or shrinkage of any moment. Unfortunately, such mounts do not keep well. It is from such a cover preparation the drawings of a grey tint have been made; while the yellow-tinted figures have been drawn (in each case using the Wollaston camera lucida) from a cover-glass preparation made in the same way, but substituting a weak chrysoidine solution for the iodine and potassic acetate, and, after five minutes, draining closely by the aid of a point of blotting-paper, drying without heat, and mounting dry. Various other plans were tried, using ammonia chromate, iodine and potassic iodide, logwood, different anilin dyes, zinc chloride, gold and silver staining, tincture of perchloride of iron, tannin, &c. Some brought out points less indicated by others, as seen in various mountants.

It has been often stated, and doubted, that the spermatozoon was occasionally provided with two heads to one filament, or two filaments to one head. I shall endeavour to show that such statements are correct, and not due to error in observation, or optical disturbance of the image by such highly refracting bodies.*

I have been able to photograph the two heads to one filament, as seen in fig. *r;* and several examples of two filaments to one head are seen in fig. *s*.

Here, I think, there can be no question about the reality of these abnormal forms. As regards the variations in the shape and union of the heads, I have been chiefly obliged to rely on my pencil. From some of the figures it will be seen how the two tails may originate. There is in the part near to the head a considerable thickening, with indication of a commencing division, which if deepened would separate the parts, and if continued through the length of the thickened filament the result would be two filaments to one head. In the large head and filament fig. *p*, there were strong indications that the filament might be split even into three. After much wearying search, I was rewarded by finding a spermatozoon having an abnormally shaped head, with three distinct filaments. Whether such a division is perfected in the original cell or in the receptacle, the vesiculæ seminales, I can offer no opinion. As regards the origin of the two heads, it is difficult to suggest more than the possibility that elongation may occur in the head and neck with a constriction, such as eventually to produce the two heads. Something of the kind is seen in figs. *l* and *q*, but I prefer to suppose them to originate by two nuclei in

* See this Journal, vi. (1886) p. 581; 'Medical World,' iv. (1886) pp. 18–20.

the original cell adhering, and furnishing between them but one filament. I have not found more than two heads with one stalk, but these are sometimes so curiously placed that I have considered they should be classed with the abnormal forms. In two instances the two heads were seen united to a larger, irregularly shaped body (fig *i*), which, as far as I could determine, appeared to be caused by the swollen agglutinated filaments of the original spirals. In few cases only had the very minute flagella (as originally discovered, I believe, by Mr. E. M. Nelson, and photographed by Mr. A. Pringle) remained adherent, as seen in fig. *i*. Sometimes the two heads may simply diverge, as in fig. *m*, or there may be for a little distance a short neck to each, as in fig. *n*. It has struck me as very singular that in one of the primary or initial elements necessary to the perfect evolution of the fecundated ovum there should be any sport or straying from the perfect form, especially in the highest mammalian. I am not aware that any similar deviation has been noticed in phanerogams; the only difference in the pollen-grains, as far as my knowledge extends, being a difference in size, although in evolved parts teratology is common.

I am aware that the products of a cell are liable to great variation, as in many pathological structures, but this scarcely removes the difficulty attendant on such a sport as has been noticed in the foregoing in an initial element. Naturally the question follows—has it finally any importance should it find an entrance and mingle with the contents of the female ovum? I think we can hardly doubt that it must have some definite influence for good or otherwise, though it may be impossible of proof. Does it furnish additional parts, or contribute to superabundant stimulation to growth? A facetious friend has suggested that two tails may be the origin of twins. This cannot be seriously entertained, as the head is also necessary for the proper evolution of the embryo, and this would not dispose of the two heads to one filament, nor of the case of triplets and more. Possibly it may give an extra impetus to the growth of the future product, or additional parts, or it may decay as useless. An answer in our present state of knowledge must remain conjectural, for we are yet ignorant how far there may be a dynamical preponderance of either the male or female initial energy, or whether both equally share in the generative impulse, and determine together the further activity of the resulting fusion—a fusion that determines inherited conformity in the final unit, a significant likeness, yet often marred in the fashioning.

By those who have not made a study of these potent motile bodies, the question may be asked, what is the general form and appearance? As seen without preparation and under a variety of methods of staining, the ovoid body or head appears as a mass of homogeneous plasm of considerable refrangibility; or, if granular, only so far as to cause a slight greyness on the transmission of light. The anterior end, with its minute filament, is generally paler than the

rest of the mass, except in the centre, which may perhaps be partly due to the organism being slightly concave. It often presents a more or less perfectly vacuolated aspect at one or more places, and in any position in the head ; in one case it was noticed in the upper part of the tail filament, fig. *c*.

At such spots, according as they are focused on or into, they may appear bright or dark, thus often simulating the appearance of a nucleolus if the mass be taken as a nucleus in the original cell—Kölliker's view. Seen on the flat, the anterior edge is often extremely delicate, but on the sides and advancing towards the filament the boundary is well marked, and after reagents it often shows a double outline, which is continued into the neck. The plasm generally appears to have separated itself into two parts differing in density, the separation being marked by a cupped line, or rather giving rise to a cupped line, the position of which is not constant, the part near the neck being generally the greyest in tint, thus presenting much the aspect of an acorn in its cup. I could not find any distinct evidence that this cupped appearance was more than optical, and I think the proof lies in the fact that this denser or greyish-looking part becomes sometimes displaced and occupies the anterior end, leaving what would represent the cupped part a perfectly clear outline. This is shown in the fig. *e*. I am therefore, I regret to say, at variance with that excellent observer, Mr. E. M. Nelson.

The attachment of the head with the filament seems at one stage to be continuous, uniform, or jointless, but often at about a distance less or equal to the length of the head there is a difference in the tint—under different reagents from that given to the rest of the filament—and where this ends it often looks as if it were crossed by a line ; and when the edges of the filament at this part are slightly enlarged, both above and below it, there is the aspect of a joint, and, even at that point, often a constriction.

How seldom, however, is the head seen separated from the filament at that point, and this seems to me to militate against the idea of a joint, though it very likely is the weak point for separation after entering the ovum. Again, if jointed at that point, we might expect the filament to be commonly bent there at a right angle ; yet this is seldom seen. Often a raggedness or roughness of the edges is noticed at the upper part of the filament, the remnant of a nuclear membrane (?).

Tracing the boundary into the filament, beyond the so-called joint, I could detect no true double outline, the slender body presenting the aspect of a flattened, attenuated rod, of very different dimensions, nor under the most diversified treatment could I detect any axial thread or fibrillar division. In some of the preparations, especially in those gold-stained, six of the heads showed a dark minute point, simulating a nucleolus, but it was so rare when we might expect it to be constant, that I am very doubtful whether such a definite point may not be accidental, and due to the method precipitating a very minute portion of the plasm, or even to the

adherence on the under surface of a stained granule of the accompanying secretion.

I do not see there would be anything contrary biologically to the existence of such a nucleolus, but its rarity seems to militate against its real or general existence, and the histological evidence yet requires to be placed either with or against the optical conclusions. Further observations, under a variety of conditions, are needed to decide this point, unless others can furnish more satisfactory proof than is known to the writer.

Unfortunately, I have not as yet been able to follow or confirm the description of the latest research on the structure of the human spermatozoon, as furnished in the pages of the October No. of the 'Annales de Micrographie,' by that careful observer, Mr. G. F. Dowdeswell.

Briefly, my friend describes and figures a kind of calix, or very delicate envelope, which partially embraces the head. This is stated to be best seen while the organism is slowly moving, and very rarely in stained and dried preparations. The existence of such an envelope adds considerable interest to the general study of these delicate generative bodies.

Since writing the above, Mr. Dowdeswell has kindly informed me that Dr. Heneage Gibbes considered the joint could always be produced by treatment with alcohol; yet, as aforestated, it is also to be found in some of the spermatozoa which have been treated in very different ways, and without alcohol. I suspect it is more or less indicative of greater maturity in the spermatozoon. Although the varied additional forms mentioned by Dr. E. Cutler, and noticed in a short paragraph in the Journal of the Society, vol. vi. p. 581, have not yet been seen, no doubt they can be found by further close examination. I am quite willing to accept his suggestion that they may sometimes cause teratological conditions in children. If "fecundation be regarded as the union of the nuclear substance of the maternal and paternal individuals," should there be a preponderance of the male element, must we not suppose it to carry some additional influence, whether towards heredity or teratology, which may evolve as a "firm friend or a deadly foe." Indeed, may not such a privileged power, fraught with a co-operative influence, originate in the resultant individual an exalted repetition of its own history, or give rise to such rejuvenescence as may restore what by misguidance may have been lost, or brought about by the disastrous storms of circumstance and faulty environment?

If tending to teratology only, perhaps some light might be thrown on the subject by a strict examination of the spermatozoa in those families where redundant parts recur through several generations.

It is to be hoped further research in the study of spermatogenesis may not only lift it out of its bewildering nomenclature, but also bring to light much that is still hidden, and of the highest interest.

II.—*The President's Address on some Doubtful Points in the Natural History of the Rotifera.*

By C. T. Hudson, LLD., F.R.S.

(*Annual Meeting*, 21*st January*, 1891.)

There is perhaps no position that so tickles our sense of humour as that of

"the engineer
Hoist with his own petard."

That the digger of a pit for another should fall into it himself, that the biter should be bit, and that the maker of a new law should himself be the first to incur its penalty, are cases that catch our fancy, with a sense of justice flavoured with fun: and so if I,

"When caught myself, lie struggling in the snare,"

I must be content to be ranked with the "wicked who is snared by the work of his own hands," and must try to make the best of the position, even if it is one which lights up the faces of my audience with a good-natured smile at my own expense. For, two years ago, in my first address to the Royal Microscopical Society, unaware of the future presidential honours which awaited me, and thinking only of the admirable summary given to us, every two months, by our able Editor and staff, I rashly said that no President in future would be able to take, as an obvious subject for his address, an account of the world's microscopic work during the preceding year; but that he would be compelled to follow Dr. Dallinger's shining example, as best he might, and offer to the Society some of the results of his own researches.

But we should beware of making general statements; especially such as concern ourselves. Indeed it seems to me that the safest general statement, that can be made, is, "that nearly all general statements will prove to be untrue": and so, in this matter, scarcely had I committed myself to what seemed a self-evident proposition, than I became aware that it no longer covered my own case. For, on the one hand, I found myself suddenly forbidden to use the Microscope; and on the other, I had already in the 'Rotifera,' in its supplement, and in my first presidential address, said almost all that I had to say on my own subject. Being then unfortunately debarred from further research, and having already told you all that I *do* know about the *Rotifera*, what remains for me but to tell you what I do *not?* And such negative information is not entirely without precedent. "A history of events which have not happened" has been suggested as one that "might enlarge our general views of human affairs;" and even a chapter or two of it has been already written. Again, it has been urged that a list of "inventions not yet invented" might excite some fertile brains to supply our wants; and so perhaps a record of the main points in the natural history of the *Rotifera*

which are yet obscure, may serve to point out to students whither they can profitably direct their course: just as the lions and elephants, on the old charts of Africa, were the sign-boards which marked out the spots, where there was good entertainment for man and maps.

Considering first the position which the class ROTIFERA holds in the Natural Kingdom, we find that it has been placed (apparently by common consent) in the limbo "Incertæ sedis"; so here at the outset we light upon a subject, that will give ample opportunity for research and study: for, while the humbler species of *Rotifera* pass by easy gradations into larva-like worms, which have almost lost the characteristic ciliary wreath and trophi, the higher species have, standing at a great distance beyond them, a true rotiferon, *Pedalion mirum*, so far advanced in its structure that it forms an order by itself; and, moreover, the gap between this order and the other three, which contain the rest of the 450 species of the *Rotifera*, is obviously too great to be real.

The forms, then, that link *Pedalion* to the others cannot be few; and are, indeed, dimly foreshadowed by the hollow stumps of *Asplanchna Ebbesbornii*, and by similar processes in several of the male *Asplanchnæ*. We have in the latter, as it were, the first rude sketch of a *Pedalion;* for though their lateral processes do not end in swimming fans, and appear to be of no use to the animal, yet they have muscular fibres passing freely along their cavities from end to end.

The male of *A. intermedia* has three such appendages, the female of *A. Ebbesbornii* has four, the male of *A. Sieboldii* has five, while that of *A. Ebbesbornii* has six. Increase the number of the muscular fibres, expand them into bands, attach them to the body-wall (as they pass the base of each process into the cavity of the trunk), and we shall then have limbs adapted for swimming, and wanting only the finish of the terminal fan to approximate to those of *Pedalion*. Indeed the female of *A. Ebbesbornii* looks just as if some species of *Pedalion* had had its limbs rounded off at the extremities, so as to rob them of their fans.

On the other side of *Pedalion*, between it and the *Arthropoda*, there lies Schmarda's *Hexarthra* which requires a special notice, as Eckstein and von Daday both consider the two animals to be identical. How they have come to such a conclusion I cannot imagine, unless they suppose that Schmarda had less power of observation than an ordinary child. For *Pedalion* is a conically shaped animal, with six limbs arranged all round the cone, parallel to its axis, and pointing from its base to its apex; how then is it possible for the merest tyro to draw those six limbs as radiating from a common base on the surface? If a half-opened black umbrella had white pieces of tape sewn outside, along its ribs, could there be any one capable of declaring that the white tape formed a star, with six rays issuing from the middle point of one of the umbrella's ribs? And yet it is a

mistake, quite as bad as this, that Schmarda is supposed to have made; and that too, in the case of an animal, of which he had numerous examples, and whose true form could be easily seen under a low power. It is probable then that *Hexarthra* exists, and that the *Rotifera*, in this species, make a still nearer approach to the Nauplius larva of the *Arthropoda*. Of course, if the *Rotifera* do run up to the *Arthropoda* through *Pedalion* and *Hexarthra*, there must be other forms lying between the outposts of the two classes, with which we are unacquainted, and which it is possible that we may yet discover. Nor do I think that I am too sanguine in supposing, that some of these connecting links, on either side of *Pedalion*, may yet be extant. For the *Rotifera*, owing apparently to their extraordinary power of adapting themselves to varying circumstances, contain more than one long series of forms connecting species that, at first sight, seem hopelessly wide apart. Place *Trochosphæra*, *Stephanoceros*, and *Actinurus* side by side; could there be a more discrepant trio? And yet we possess many intermediate forms which link the three together.

The persistence of such links gives us, I think, good ground for hoping that the missing forms, between *Pedalion* and the other *Rotifera*, may yet exist; and (whatever may be thought about *Hexarthra*) possibly some too between *Pedalion* and the *Arthropoda*. At any rate it is worth while to try to find them; and, if so, where can we search with the best prospect of success? It is hardly likely that their natural homes are in Europe, or the United States; for, if they were, they could hardly have escaped the sharp eyes there, that are ever prying for novelties; it is in the tropical and semi-tropical countries that we must conduct our search. Their lakes, tanks, flooded rice-fields, swamps, and irrigation-canals—all sweltering under the sun, and abounding in minute vegetation—have surely a wealth of new microscopic creatures yet in store for us. I only know of four observers, who have had the good fortune to explore these almost virgin fields of research, and each has found at least one prize. Dr. Semper discovered the female of *Trochosphæra æquatorialis* in the flooded rice-fields of Manila; Dr. Schmarda *Hexarthra*, in the irrigation canals of Egypt; Surgeon Gunson Thorpe, R.N., the male of *Trochosphæra æquatorialis*, near Brisbane; and Mr. Whitelegge, at Sydney, that curious social Melicertan *Lacinularia pedunculata;* which, anchored by its long thread of intertwined stems to the leaves of *Myriophyllum*, floats on the surface of shallow pools, "like acacia blossoms that have fallen into the water from the trees above."

Pedalion, too, which has given rise to this question, itself would seem to suggest the same answer. For it is a very rare creature, and does not thrive in our ponds, dying out after the first or second year. The only spot where it seems more at home is in the warm water lily-tank in the Duke of Westminster's conservatory at Eaton. This

inclines me to think that it may be a sub-tropical species, whose ephippial eggs are occasionally wafted to England; especially as it has been found in great abundance, by Surgeon Thorpe, on a rocky island off the coast of Queensland.

But unfortunately those of our friends, who are spending the prime of their lives near the Equator, are necessarily too busy with more important matters to give up their time and thoughts to such researches; yet I think that there is a way in which they might effectively help us, without incurring much trouble or expense. If they would send us the hard earth pared from the surface bottom of dried up pools, it would most probably bring over, with it, ephippial eggs of tropical Rotifera; and, as these are constructed to bear a dormant condition for nine months or more, they would travel safely across the globe, and come to life in our aquaria at home. No doubt many such chance ventures would prove failures, but to hit the mark one must often throw many a stone. If we now turn from the unknown Rotifera that we wish to find, to the unknown points in those that we have found already, we shall be comforted by seeing that there is still an encouraging store of ignorance awaiting attack.

In the first place, there is much yet remaining to be discovered about the reproduction of the Rotifera. Although the dicœcious character of the class as a whole has been established, yet it is a reproach to naturalists that so common an order as the *Bdelloida* should as yet have presented us with nothing but an unbroken succession of virgin mothers. There is nothing in the internal structure of any of the species to lead us to suspect that they are other than dicœcious; all the organs are accounted for, and the female organs are precisely like those of the other orders, yet no one has seen the male. With such hardy creatures as Philodines, Rotifers, and *Adinetæ*—creatures to whom extremities of heat, cold, and drought are the ordinary incidents of life—nothing is easier than to keep an abundant stock all the year round; and so, one would think, to make sure of finding the male. Possibly the male and female fœtus resemble each other so much, as to be not easily distinguished when *in utero*: possibly, too, the males are rare, or very small, or live only for a very short period:—and it is possible that all these conditions may exist together. If so, it would be no wonder that they have as yet escaped mere random observation. But patient, persistent, daily search through small aquaria well stocked with these creatures, must lead at last to the discovery of the Bdelloid male.

But the search for a missing male is a light matter compared with that of settling the yet doubtful points in the reproduction of the Rotifera; points on which some of the best observers hold very different opinions.

It would be impossible for me to discuss this question within the limits of this paper, but I will endeavour to give a brief summary of

the differing theories, and suggest experiments which might, I think, decide between them.

There are, as no doubt you are aware, three sorts of eggs among the Rotifera. Of these the ordinary, or "summer" eggs, have only a soft membranous covering; they are hatched soon after they are laid, and are of two sexes, distinguished from each other by both shape and size. The female eggs are large and distinctly oval; the male eggs are smaller and nearly spherical. The third sort of egg, or "ephippial" egg, has a double shell, often beset with spines, bosses, or prickles. It is sometimes termed a "winter" egg, but this is a misnomer, as it occurs at all times of the year.

Now there is no doubt of the continued production of female eggs by parthenogenesis in every family of the *Rotifera;* and indeed, among the *Bdelloida* no other mode of reproduction has as yet been seen: but concerning the origin of ephippial eggs there is no such agreement. Cohn thinks that they are the product of sexual intercourse; Huxley says that sexual intercourse gives rise to the ordinary soft-shelled eggs; Plate maintains that sexual intercourse has no effect in determining the sort of egg that is to be laid. Again, Plate declares that no female ever lays more than one sort of egg; while Balbiani, on the contrary, says that the same individual may first lay ordinary female eggs and then ephippial eggs.

It is not easy to steer one's way through such contending authorities; but before making the attempt, let us first separate the facts from the opinions.

(1) It is admitted on all hands that virgin females will produce virgin females, in unbroken succession, through many generations.

(2) Balbiani states that he has often observed, that a solitary female of *Notommata Werneckii*, inclosed in a gall of *Vaucheria*, has first laid ordinary female eggs, and then ephippial eggs: and that the laying of the latter was preceded by a gradual exhaustion of the vitality of the germ in the ordinary female egg, as shown by a great number of them remaining sterile; or, if the embryo were formed, by its dying without hatching, even after the eye-spot had become visible. Moreover, the males had nothing to do with the matter, as they were absent during the whole of the observations.

(3) Huxley has observed in *Lacinularia socialis* that the ephippial egg is formed out of several germs and their surrounding yolk; and I have myself watched the entire process of the formation of an ephippial egg in *Conochilus volvox*, and seen that it consisted of nearly two-thirds of the ovary, with many inclosed germs.

(4) Plate has tried many experiments in coupling females (that had already begun to lay eggs) with males; and in no case did sexual intercourse alter the kind of egg that the female had been in the habit of laying.

(5) In two cases Plate observed the results of coitus on a young

female, that had laid no eggs before intercourse with the male; and, in both cases, she laid ordinary female eggs.

(6) Plate has seen the hatching of two ephippial eggs of *Hydatina senta*, and Joliet one of *Melicerta ringens*, and in each case the ephippial egg produced one female.

It is probable then, from the statements above, that the ephippial egg is not due to the action of the male; but that it is the termination of that budding process, by which virgin females produce virgin females through many generations, and that it is resorted to when the vigour of the ovary begins to fail, so that a single germ is no longer able to produce a living animal. When this time arrives many germs are separated off to do the work for which one is usually sufficient, and so combine together to produce one embryo for the next year. The double egg-shell with its deep cells, and various knobs or spines, may be due to a surplusage of material in this joint-stock egg-making.*

Of the series, of which the ephippial egg is the end, it is probable that an ovary impregnated by the male is the beginning; but this point, as well as the doubts that yet linger about the above account, could surely be cleared up by patient experiment.

It would be easy, for instance, to isolate, as soon as it is hatched, a female of each succeeding generation of a *Hydatina senta*, and to see how many generations may be thus produced; and whether the series invariably ended in a female laying ephippial eggs. There should be, moreover, two such series; one commencing with a female impregnated before she had laid any eggs, the other with a virgin female. As *Hydatina senta* is a common, large, and very prolific Rotiferon, as well as one that may be easily fed with *Euglenæ*, &c., the experiment would not be very troublesome. Possibly, too, such experiments might throw some light on the causes that give rise to the laying of male eggs; about which at present we do not seem to know anything.

There are two other points in the reproduction of the *Rotifera* which are puzzling. The first occurs in *Rotifer vulgaris* and its allied forms. In these the eggs drop off the ovary into the perivisceral cavity, and are hatched within the animal; and the young rotifer seems to lie free in the cavity, for it can stretch itself to its whole length, or twist round and reverse its position without apparent hinderance from any inclosing membrane. In the act of birth it has been seen to pass through the cloacal aperture; and one observer noticed a young *Rotifer vulgaris* protrude its head, expand its wheels in the water, and then furl them and shrink back within the

* M. Joliet's observations on the hatching of the ephippial egg of *Melicerta ringens* (Comptes Rendus, xciii. (1881) p. 856) point in the same direction. For he noticed that the young female hatched from the ephippial egg had the perfect form of the adult *Melicerta*, and was therefore in an advanced stage of growth compared with the young hatched from the ordinary thin-shelled egg.

parent. But how it can do this is a puzzle. Neither ovary appears to have any connection with the cloaca, and the young rotifer seems to be in the body-cavity *outside* of the closed tube which passes from the cloacal outlet to the lower stomach. I have suggested* that the long thread which passes from the posterior end of the ovary towards the cloaca, may really be not a muscle, as is usually supposed, but the collapsed oviduct; and that when the ovum becomes detached and seems to fall into the perivisceral cavity, it does not really do so but simply stretches out over itself the delicate membrane investing the ovary; for the collapsed oviduct, which is a prolongation of this membrane, would at once yield to the slightest pressure, and accommodate itself to the increasing size first of the ovum, and afterwards of the embryo; while the extreme tenuity of the membrane may have caused it to escape notice when expanded over the young. However, this is only a guess; for I have never seen any such membrane, and the difficulty is still waiting for its explanation.

The next point is the frequent presence of spermatozoa in the perivisceral cavity. It is as perplexing to explain how they get into this cavity, as how young *Rotifer vulgaris* gets out of it. Coitus has been seen to take place in several species of *Rotifera*, and by various observers; and with the exception of Dr. Plate, all observers agree that it takes place at the cloaca, into which the oviduct opens. Neither the oviduct, nor the cloaca, is known to have an opening into the perivisceral cavity, and yet the spermatozoa in several species have been seen in that cavity, adhering to the outside of the ovary. How did they get there? †

There may, perhaps, be minute openings in the oviduct through which the spermatozoa can pass into the perivisceral cavity, but I

* 'Rotifera,' i. p. 103, footnote.

† Dr. Plate describes experiments in which he has seen several males (in number varying from two to eight) having intercourse at the same time with the same female. He describes them as firmly fastened by the penis to various parts of her body; and he asserts that the penis bores through the body-wall, anywhere, and ejects the spermatozoa, and the rod-like bodies which accompany them, into the body-cavity. Further on, however, he qualifies this statement by saying that he never could find any traces of an opening in the cuticle, at the spot where copulation appeared to have taken place; that the penis appeared to be glued on outwardly; and that finally he believed that it was the stiff bristles of the penis which penetrated the cuticle, and gave a passage to the spermatozoa.

It is not necessary to comment further on this strange theory than to say, that Gosse has seen intercourse take place at the cloaca in the case of *Brachionus pala*; M. E. F. Weber in that of *Diglena catellina*; and Mr. J. Hood, not only in *Floscularia ornata*, *Synchæta gyrina*, *Euchlanis triquetra*, and *Melicerta tubicolaria*, but also more than a score of times in *Hydatina senta* itself.

Mr. Hood further states, in the letter with which he has favoured me, that the female Rhizota (whose copulation he has often witnessed) "draw themselves up in their tubes, so as to bring the orifice of the cloaca above the upper edge." He also says that *Hydatina senta* copulates while clinging with her foot to some confervoid filament, but *Synchæta gyrina* copulates while swimming.

The duration of contact, according to Mr. Hood, is from forty seconds to two minutes in *Hydatina senta*, and three to three and a half minutes in *Floscularia ornata*.

know of no one who has seen such openings. Or it is possible that the spermatozoa may pass through the walls of the oviduct, just as white corpuscules pass through the walls of the capillaries. And though it is hardly likely that this should be their regular path, yet it is obvious that they are capable of penetrating the membrane, which covers the ovary and is prolonged into an oviduct, for they have been seen to attach themselves to the external surface of the ovary,* so that their contents must pass through the membrane to get at the germ.

There remains one more organ that is waiting for a skilful experimenter and observer, viz. the contractile vesicle with its lateral canals and vibratile tags. Various functions have been ascribed to this group of vessels. It has been described as a male sexual organ, as a respiratory organ, and as an excreting one. The last explanation is the one now usually given; but there are difficulties in the way of its complete acceptance which have not as yet been met.

The theory is that the lateral canals, aided by the vibratile tags, gradually fill the contractile vesicle with a secretion derived from the perivisceral fluid; and that the contractile vesicle, as soon as it has reached its full distention, discharges this fluid through the cloaca.

Now it can be readily demonstrated that the contractile vesicle does discharge its contents through the cloaca,† but it is not easy to credit that these contents consist solely of a secretion derived from the perivisceral fluid. For the contractile vesicle, owing to its rapid and continuous action, often discharges in a minute or two a quantity of fluid equal to that of the whole body. Take for instance the case of *Mastigocerca carinata*. Gosse observed that the discharge took place twenty-five times in a minute; and, as the volume of the vesicle is greater than one-tenth of the perivisceral fluid, it would follow that the creature renews the whole of its body-fluids at least twice in a minute. Is this likely? and, if it could be established as true, what could the perivisceral fluid be but mere water drawn from without? *Secretion*, at such a rate, seems impossible. What, too, shall we say of the great contractile vesicles of some of the *Asplanchnæ*, filling more than half of the body-cavity? Or of that of *Brachionus militaris*, expanding even to two-thirds? Is it probable that they are filled with a *secretion?*

Moreover, that practised observer Cohn declares, that he has seen particles of pigment first driven away by the rush of fluid from the contractile vesicle, and then carried by a return current, through the cloaca, right into the vesicle; while other particles, turned back by its contraction, were violently driven out again from the cloacal aperture.

* Dr. Cohn and myself have seen this in *Conochilus volvox*.

† By compressing a young *Asplanchna Ebbesbornii*, so as to check slightly the action of the contractile vesicle, I have caused partial contractions, each of which has been seen to send a plug of fluid down the oviduct to the cloaca. I have also successfully tried the same experiment on *Hydatina senta*.

I do not see how we can decline to accept such a precise statement, made as it is by an expert; and, if we admit its accuracy, how can we escape from the conclusion, that the fluid, which distends the contractile vesicle, is probably little else but water drawn in through the cloaca?

And, should this explanation prove to be correct, there would then be no difficulty concerning the quantity of fluid, so frequently expelled from the contractile vesicle. The lateral canals and vibratile tags might then be considered, as before, to form a secreting organ, whose secretion did indeed enter the vesicle, but was there so diluted, with water drawn up from the cloaca, that it in no way injured that water in its office of aerating the perivisceral fluid through the delicate wall of the vesicle.*

To sum up, then, I think that of the various explanations offered of this perplexing system of organs, the most probable one is that it is an excreto-respiratory one; the contractile vesicle performing the function of respiration, and the lateral canals that of secretion; and that these functions remain unaltered, whether the lateral canals are united to the vesicle or not. It is evident, however, that to place this explanation beyond doubt, Cohn's experiment should be repeated several times; *Trochosphæra* should be thoroughly re-examined; a record should be kept of the rate at which the vesicle contracts in various species; and an estimation made in such case of the ratio of its volume to that of the perivisceral fluid.

The study of such minute details, no doubt, is dry, and I am afraid that my recital of them has proved wearisome; but then natural history, to a large extent, *is* a study of minute details, which, indeed, must always be its sure foundation. And yet this study has its compensations; for while engaged in it, laying the foundations of such a work as man generally raises—solid perhaps, certainly formal, and probably heavy—I became aware of the silent growth, on the same foundation, of a palace of delight, into which I could enter at a wish, and leave the world behind me. Here could I roam through pleasant chambers, rejoicing in their treasures of memory—in their store of early fancies glittering in the light of happy youth—and in strange prizes, won in dear companionship, among all the charms of cliff, combe, sea, and sunshine. Here, too, were corridors of half-formed thoughts, stretching out into that enchanted region where a few grains of fact, like a drop or two of a compressed gas, expand into clouds of ideas, hazy, yet tinted with the hue of hope—clouds that

* Now the probability of this theory being true is strengthened by the case of *Trochosphæra æquatorialis*. For Semper distinctly states that in *Trochosphæra* the lateral canals are entirely detached from the contractile vesicle; and that, instead of terminating on its surface, they both pass below it to the cloaca, and open just at the cloacal aperture. With such an arrangement of the parts, it is hardly possible to suppose that the contractile vesicle is distended by fluid discharged from the canals. So here, too, we seem driven to the conclusion, that water drawn through the cloaca is the principal agent in the distention of the vesicle.

soften the hard features of modern science, and seem as if they would some day lift a little, and give glimpses of possible replies to the three eternal questions: "Where did we come from?" "Why are we here?" "Whither are we going?" Here, too, could I please myself with thoughts that rose unbidden as I reflected on what I had seen in the world beneath the waters. What happiness reigns there! What ease, grace, beauty, leisure and content! Watch these living specks as they glide through their forests of algæ; all "without hurry and care," as if their "span-long lives" really could endure for the thousand years that the old catch pines for. Here is no greedy jostling at the banquet that Nature has spread for them; no dread of each other; but a leisurely inspection of the field, that shows neither the pressure of hunger nor the dread of an enemy.

"To labour and to be content" (that "sweet life" of the son of Sirach)—to be equally ready for an enemy or a friend—to trust in themselves alone—to show a brave unconcern for the morrow—all these are the admirable points of a character almost universal among animals, and one that would lighten many a heart were it more common among men. That character is the direct result of the golden law, "If one will not work, neither let him eat;" a law whose stern kindness, unflinchingly applied, has produced whole nations of living creatures, without a pauper in their ranks, flushed with health, alert, resolute, self-reliant, and singularly happy.

Another thing that has struck me greatly is that "the struggle for existence" leaves them so much leisure, and such famous spirits. Even the Swift can find time to play. From early morning late into the twilight, it rushes through the air, crushing into a summer's day the emotions of a season's fox-hunting; and then, having "provided for those of its own house," it takes its ease in darting from sky to earth, at eighty miles an hour, shrieking with delight in a mad game of "catch-who-catch can."

During the late hard frost, all the hills where I live, were alive with tobogganners—an unwonted sight in the south-west; but the rooks invented the game long ago. I have often watched them at Ilfracombe in the evening (when a strong north-wester was blowing) flying low above the town, from the Manor House trees, to the landward slopes above the tunnels. There, closing their ranks and sheltered by the slope, they rose, almost brushing the grass, till, at the very edge of the cliff they were caught by the wind, and hurled, in a whirl of wings, back to their rookery; whence after much fluttering and cawing, they again set out for the cliffs.

The slow toilsome approach, the mad return, the intoxication of headlong flight, and the spice of possible danger, are the same in both games; but the birds have the best of it; for no policeman ever wishes to interfere with their sport; and they can enjoy it if they please, nearly all the year round.

The *Rotifera* occasionally play; at least I think so. You may

sometimes see, floating in the water of a live-trough, a tangle of what looks like spider's web. It is, I believe, a chance gathering of the threads spun by a swarm of the larger *Rotifera*. On one of these threads, I have sometimes seen a line of minute creatures (1/250 in. long) hanging on by their toes, and whirling round, one after another, like boys on an iron railing, or rather like professional athletes on a horizontal bar. It is hardly possible that they get their food in this way, for the pace is so great; besides, at other times, they flit about among the algæ with a decorum much more suitable to the important business of dining.

But why should I adduce further examples? Higher up in the scale, the games of animals are obvious to all; as are also, I think, their health, their leisure, and their happiness. Where they lead unhealthy and unhappy lives, I fear that man's brutality, or his injudicious kindness, are too often to blame.

All such speculations as these, however, lead to burning questions; for man is much too closely kin to the lower animals not to be conscious, that the laws, which affect their conduct, are but a rough sketch of those which affect his own. Still I may be permitted to say, without offence, that we have much to learn from our dumb brethren; and that we sometimes cut sorry figures compared with them. Indeed, we can only wince and be silent, when we read the caustic lines that sum up the discourse of Luath and Cæsar,—

> "Then up they gat, and shook their lugs,
> Rejoiced they were na *men* but *dogs*."

Of the outward condition of the brute creation, and of the happiness that falls to its lot, we can perhaps form an opinion that approximates to the truth, though even here the same facts receive widely different interpretations. But of the sensations and emotions of the humbler animals what *can* we know? Of the import to them of those phenomena, which make up our own familiar world, we cannot conjecture. We can but make feeble guesses at the causes of their actions; causes lost in one of the profoundest abysses with which our reason can attempt to cope. I have seen actions among the *Rotifera* that seemed to betoken the possession of memory, consciousness, and choice; but, without the means of testing the matter by experiment, it would be rash indeed to assert that they possess them. Still, what could *look* more rational than the following conduct in a *Floscularia campanulata?* It had stretched itself well out of its case, and, fully expanded, was drawing one victim after another down to the bottom of its coronal cup, when there slipped into the latter, almost filling it, a *Euplotes charon*—one of the oval, style-bearing Infusoria. Now the Floscule's habit, when it is disturbed, is to fold up its cup, draw it into its body, and dart back into its tube. It does this scores of times during the day, and a whole series of actions—the pressing of the lobes of the cup together, their proper folding, their withdrawal within the body, the contraction of the foot,

and the consequent darting to the bottom of the tube—bring into play a number of various muscles. These are all practised to act together with the utmost precision and swiftness; and I never, except on this occasion, saw them act otherwise than in concert. But to have done so now would have been to have caused a struggle between the Floscule to get into its tube, and the *Euplotes* to get out of the Floscule's grip; in which the cup's delicate walls might have been much injured. So the latter did the only thing that there was to be done with safety. It slowly contracted its foot while *distending its coronal cup to the utmost;* and, making as it were a graceful curtsy, gave the *Euplotes* a free passage.

Here, then, was an unusual danger met promptly by the reversal of one of a group of related actions, which habit must have made almost inseparable. It *looked* as if the Floscule had consciously adopted this mode of escape from its awkward position; but, as Hamerton has well said, "the impossibility of knowing the real sensations of animals—and the sensations are the life—stands like an inaccessible and immovable rock right in the pathway of our studies. None of us can imagine the feelings of a tiger when his jaws are bathed in blood, and he tears the quivering flesh. The passion of the great flesh-eater is as completely unknown to civilised men, as the passion of the poet is to the tiger in the jungle. It is far more than merely a good appetite; it is an intense emotion."

The main difficulty in conceiving the mental state of animals is, that the moment we think of them as *human* we are lost. But the hopeless absurdity of trying to fancy how life looks and feels to a Floscule, is only a trifling instance of what meets us at every turn; our speculations constantly leading us to abysses in which thought does not so much lose itself, as expire.

Curiosity may tempt us to peer into the darkness; but if we wish

> "To take what passes in good part,
> And keep the hiccoughs from the heart,"

we must turn back to sunshine and our beautiful earth, existence on which is acceptable almost on any terms. It has delights for our senses, satisfaction for our affections; and, for our minds, a store of marvels which the longest life can never exhaust. For the softer consolations of hope, for dreams of the future, for the recovery of lost love, and the re-uniting of snapt heart-strings, we must step into the realm of Faith, clinging to our hopes, and declining "to lose *ourselves* while seeking for our primary cell."*

Sir Thomas Browne's advice is as good now as it was 250 years ago: "Desert not thy title to a divine particle. Have a glimpse of incomprehensibles, and thoughts of things, which thoughts but tenderly touch."

Science, though it has its own religion of wonder and reverence,

* 'Horæ Subsecivæ,' Dr. John Brown.

is in such matters hemmed in by barriers impassable by human reason ; and knows as little of first causes, as it does of last consequences. Yet from the drama of animal life we may learn wholesome lessons. Here Nature suffers us to guess at her wishes, from her acts ; and so judged, we may well say of her, that

"She too is no mean preacher."

For though her precepts are few, they are burnt into her pupils by her unvarying practice ; as, almost from birth to death, from the Primates to the Rotifers, she trains up her dumb children in the exercise of that splendid virtue—fearless Self-reliance.

SUMMARY

OF CURRENT RESEARCHES RELATING TO

ZOOLOGY AND BOTANY

(*principally Invertebrata and Cryptogamia*),

MICROSCOPY, &c.,

INCLUDING ORIGINAL COMMUNICATIONS FROM FELLOWS AND OTHERS.*

ZOOLOGY.

A. VERTEBRATA:—Embryology, Histology, and General.

a. Embryology.†

Preservation and Accumulation of Cross-Infertility.‡—The Rev. J. T. Gulick regards physiological segregation as including all kinds of incompatibility between the male and female elements of different groups, however closely or however widely they may be separated; he urges that the importance of this principle in the origin and continuance of different groups cannot be exaggerated in the case of organisms whose fertilizing elements are fully distributed by wind or water; in those cases the segregate compatibility and cross incompatibility of the male and female elements may be the means by which the prevention of free crossing is secured, as well as the means by which the swamping effect of the crossing that occurs is prevented.

Experimental Studies on Ova.§—Prof. O. Hertwig discusses under this title a number of strange facts.

(1) *The effect of over-ripeness.*—At Trieste, in April 1887, the majority of the sea-urchins (*Echinus microtuberculatus* and *Strongylocentrotus lividus*) seem to have been in a pathological condition. The reproductive organs were over-ripe; the ova would not fertilize at all, or were more frequently susceptible to multiple fertilization, containing sometimes a score of sperm-nuclei; segmentation, if it did begin, was very abnormal. As Professor Hertwig does not believe in the possibility of unfavourable external conditions having a direct effect on the reproductive elements, he inclines to think that spawning had been

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

† This section includes not only papers relating to Embryology properly so called, but also those dealing with Evolution, Development, and Reproduction, and allied subjects. ‡ Amer. Journal of Science, cxl. (1890) pp. 437-42.

§ Jenaische Zeitschr. f. Naturwiss., xxiv. (1890) pp. 268-313 (3 pls.).

somehow prevented, and that an injurious over-ripeness of both spermatozoa and ova, but especially of the latter, resulted.

(2) *The influence of cold on the reproductive elements.*—Ova of sea-urchins can survive a temperature of − 2° or − 3° C., but the changes which are associated with fertilization are much modified. Thus the vitelline membrane was imperfectly formed or suppressed, according to the duration of the refrigeration. The receptive prominence where the protoplasm of the ovum usually reacts to the stimulus of the penetrating spermatozoon was formed slightly or not at all. At the beginning of refrigeration normal fertilization might be observed, after half an hour polyspermy occurred, in the second hour no fertilization. More rapid than any other change was the disappearance of the usual radiate figures in the protoplasm of the ovum. The author then describes in detail the remarkable influences of lowered temperature on segmenting ova.

(3) *Staining living cell-substance with methyl-blue.*—Ova of *Strongylocentrotus lividus* placed for a short time in strong solutions of methyl-blue, or for a longer time in weak solutions, take up the pigment readily. The more they absorb, the more their future development is retarded. When returned to pure sea-water, they retain the colour for a while, and the pigment is observed at the bases of the ciliated cells in the blastula stage.

(4) *Parthenogenesis of Starfish.*—Prof. Hertwig was able to confirm Greeff's observation that ova of starfishes might begin to develope without fertilization. The ova of *Asterias glacialis* and also of *Astropecten* were sometimes seen to segment, usually in abnormal fashion, without any fertilization having occurred. In some cases the blastula stage was attained, and these blastula embryos were without any vitelline membrane, which is only formed when fertilization is effected. Though the observations on the formation of polar bodies in these parthenogenetic ova were not very conclusive, they seem to indicate that a second nuclear division, but no second extrusion takes place, a fact of obvious interest in connection with the theories as to the relation between the formation of polar bodies and parthenogenetic development.

Maturation of the Ovum of the Fowl.*—Prof. M. Holl begins his account with a description of the ova of the newly hatched chick which are not yet inclosed within follicles. He then sketches the origin of the *tunica adventitia* (or vitelline membrane), of the *membrana granulosa* (or follicular epithelium), and of the *membrana propria*, all of which arise from the stroma of the ovary. As maturation proceeds, the nucleus undergoes a series of changes:—it seems to move from the centre to the surface, thence inwards, and finally once more outwards, with slight changes of form meanwhile; the nuclear membrane disappears; so does the nucleolus; the chromatin substance, at first a fine network, becomes distributed in small granules, but collects again in six chromatin rods, whose appearance is probably to be associated with the formation of polar bodies. Considerable attention is paid to the remarkable yolk-nucleus which lies near the germinal vesicle, and to the peripheral increase of the yolk. The author then describes the appearance of the *zona radiata*, which he regards as a product of the cells of the *membrana*

* SB. K. Akad. Wiss. Wien, xcix. (1890) pp. 309-70 (1 pl.).

granulosa, and traces the subsequent changes that occur round the ripening ovum in the "vitelline membrane" and "follicular epithelium."

The Pressure within the Egg of the Fowl.*—Sig. L. Tarulli finds that internal varnishing of the air-chamber of the egg prevents development, except in the first stages. The pressure is much affected, and the respiration but a little. External varnishing of the air-chamber is also followed by disturbing results, but the pressure after being increased returns to the normal, through the use of the unvarnished region. When the air-chamber is filled with oil, and thus completely varnished internally, there are no traces of development. Varnishing the egg not only hinders respiration, but affects pressure and temperature. The air-chamber regulates pressure, the surface of evaporation regulates temperature. It is only when these two conditions are naturally fulfilled that respiration can remain normal.

Formation of a Double Embryo in the Hen's-egg.†—Prof. W. Baldwin Spencer describes an egg in which two clearly formed embryos were developed within the limits of one blastoderm. The two embryos are precisely similar to one another; each is in the stage at which the nervous system has the form of a tube, the anterior end of which is becoming swollen out to form the vesicles of the brain; at the posterior end the neural canal is still widely open. Apparently every stage may be met with between this complete reduplication and that in which one portion only of the body is doubled. Prof. Spencer points out that there are three ways in which this doubling may have been brought about. As in the case of *Lumbricus trapezoides* there may be division of the at first single and normal embryo, but that could hardly have happened here, as the surrounding areæ show no trace of division. Two distinct nuclei may have been inclosed abnormally within the protoplasmic material of one ovum; but then we should expect two blastoderms. The third chance is the most probable, namely that the very first division of the nucleus was abnormal, and its products may have been qualitatively and quantitatively precisely similar, and not, as we may suppose to be the case in normal division, slightly different. This explanation will suffice also for the case, recorded by Mr. A. H. S. Lucas,‡ of a partially double chick embryo; and in fact, all cases of incomplete division may be explained by it. In these abnormal segmentation, resulting in the production of two halves precisely similar, only takes place at a later stage, and so only affects certain cells (or their nuclei) which will give rise to certain organs of the body. The earlier in segmentation the abnormal division takes place, the larger is the part of the body affected.

Maturation of Amphibian Ova.§—Dr. O. Rossi has been studying the maturation of the ovum in *Triton* and *Rana*. He finds that the germinal vesicle undergoes preliminary modifications within the ovarian ova, and that the ova from the base of the oviduct show no trace of germinal vesicle as such. He believes that a complete dissolution, and

* Atti e Rend. Accad. Med. Chirurg. Perugia, ii. (1890) pp. 121–34.
† Proc. Roy. Soc. Victoria, ii. (1890) pp. 113–5 (1 fig.).
‡ T. c., pp. 111–2 (1 fig.).
§ Anat. Anzeig., v. (1890) pp. 142–3.

perhaps partial digestion, of the nucleus takes place as the ova leave the ovary, or as they pass through the uppermost part of the oviduct. We await further details.

The Formation of the Zona Pellucida.*—Prof. G. Paladino refers to what G. Retzius recently † maintained in regard to the connections between follicular cells and the ovarian ovum, and cites some passages from a work of his own ‡ published in 1887, in which he described the intercellular protoplasmic bridges between the ovarian ovum of the rabbit and the surrounding follicular cells. The result of this nutritive connection is a reticular layer around the ovum. It is thus, namely from the follicular cells, that the *zona pellucida* arises, and its variable appearance, its presence or absence, are readily explained. It is an accessory stratum of no constancy or intrinsic importance.

Fœtal Membranes of Chelonia.§—Dr. K. Mitsukuri has investigated the fœtal membranes in *Clemmys japonica* and *Trionyx japonicus*. Among the interesting discoveries which he has made, he has discovered that the extra-embryonic cavities of the two halves of the amnion are never united with one another over the dorsal region of the embryo. A connection between the amnion and the serous envelope separates them to the very end of development and may be called the sero-amniotic connection. As may be supposed it causes great peculiarities in the fœtal membranes, in later stages. The anterior and lateral folds which, starting from the head, have gradually extended backwards over the whole embryo, do not stop at the posterior end of the embryo but continue to grow backwards; there is thus produced a tube which extends backwards from the posterior end of the embryo and is almost as long as the embryo itself; it connects the amniotic sac with the exterior. It is possible that its function is to convey nutritious matter from the white yolk into the amniotic cavity.

At one spot a small mass of white persists for a long time; it seems to undergo some change in its chemical composition for it becomes much denser and is sticky. The membranes are often slightly indented to receive this mass, and into it a low thick process of the membranes is sent; the cells of the outer layer of the serous envelope in this process are peculiarly modified, and there can be no doubt that they absorb albuminous particles from the white. This seems to be a very primitive condition of the structure described by Duval as the placenta in Birds.

Formation of the Notochord in the Human Embryo.‖—Prof. J. Kollmann has been able to demonstrate the origin of the notochord in a human embryo 14–16 days old, consisting of 13 metameres, and measuring 2·5 mm. in length. He finds that it arises in the ordinary way as an axial differentiation of endoderm along the dorsal mid-line of the gut. Kollmann maintains that in the lower Vertebrates (*Amphioxus*, Selachia, Urodela, and probably in Teleosteans and Ganoids) the notochord arises from the endoderm alone, i.e. from the "chordal-entoblast,"

* Anat. Anzeig., v. (1890) pp. 254–9 (1 fig.).

† Verh. Anat. Ges., 1889, pp. 10–11.

‡ 'Ulteriori ricerche sulla distruzione e sul rinuovamento continuo del parenchimo ovarico,' Napoli, 1887, 230 pp. and 9 pls.

§ Anat. Anzeig., v. (1890) pp. 510–9 (12 figs.). ‖ T. c., pp. 308–21 (3 figs.).

but that in mammals and probably in Sauropsida the mesoderm shares to some extent in making it. His present investigation shows that in man the notochord has certainly its main foundation in the endoderm.

Development of Vessels and Blood in the Embryonic Liver.*—Dr. P. Kuborn finds that the formation and the increase of the giant-cells in the embryonic liver of sheep are due to the extension of the vascular plexus. Nucleated prolongations grow out from the endothelial cells forming the walls of the vessels, increase the vascular channels, and give rise in so doing to giant-cells. The giant-cells form the walls of vascular cavities, also hyaline cells which become red blood-corpuscles (erythroblasts of Löwit), and part of the liquid in which these float. But when the embryos have attained a length of 3–4 cm., the process becomes more complicated, for within the giant-cells and beside the red cells which continue to be formed there, special hæmatid cells ("hématies") appear. These are developed in the protoplasm of the giant-cell as little spherical corpuscles, impregnated with hæmoglobin. They become more and more distinct from the cell-substance in which they arise, are eventually liberated, and join the colourless and red cells in the vascular cavity.

Relation of Mesonephros to the Pronephros and Supra-renal Bodies.†—Dr. R. Semon has investigated this problem in embryos of *Ichthyophis glutinosus*. (1) The pronephros has a Malpighian body as well as the mesonephros; and though a segmental constriction of this body is not demonstrable, there are some hints of segmental structure. (2) The pronephric Malpighian body is a diverticulum of the body-cavity; those of the mesonephros are also secondarily constricted cœlomic diverticula. (3) The mesonephric canals with their Malpighian bodies represent the second (dorso-lateral) generation of the pronephros and its Malpighian body. (4) The non-nervous (inter-renal) portion of the supra-renal bodies is nothing more than the distal portion of the Malpighian body of the pronephros, which has undergone great modifications—degeneration of the glomerulus and of the efferent canals, besides loss of the lumen. (5) The reproductive organ also lies in a diverticulum which was constricted off in the formation of the Malpighian body of the pronephros. The testicular network and the vasa efferentia in the male, the so-called medullary strands in the female, are anastomosing cavities derived from the original diverticulum. At first there was a connection with the Malpighian body of the pronephros, but after this was modified to form the inter-renal portion of the supra-renal body, the connection was with the Malpighian body of the mesonephros, itself a derivative of the pronephros. Sometimes, indeed, both connections persist.

Development of Urinogenital Apparatus of Crocodiles and Chelonians.‡—Prof. R. Wiedersheim finds in Crocodiles and Chelonians undoubted signs of a pronephros. Rather late in development it undergoes degeneration and consists only of a few glandular canaliculi which open by ciliated nephrostomes into the most anterior part of the cœlom. On either side, and near the pronephros there is a large vascular coil

* Anat. Anzeig., v. (1890) pp. 277–82. † T. c., pp. 455–82 (8 figs.).
‡ Arch. f. Mikr. Anat., xxxvi. (1890) pp. 410–68 (3 pls.).

(glomus) covered by cœlomic epithelium, projecting freely into the peritoneal cavity and turned towards the mesentery. Neither of these parts gives any signs of segmental origin. The glomus is multilobate but single, though it extends over more than four segments; it does not completely disappear till the Müllerian duct opens into the cloaca. It is probable that the glomus, and, with it, the whole system of pronephros, extended, in the primitive Reptiles, through the whole cœlom. The pro- and archi-nephros pass into one another without any distinct boundaries between them. A pronephric duct which later becomes the archinephric is distinctly developed, as in other Vertebrates, but it could not be decided from which germinal layer this duct arose. In the anterior region of the excretory organ there are numerous nephrostomes provided with ciliated epithelium, which are, in the earlier embryonic stages, arranged in an altogether segmental manner. In opposition to other Reptiles the Crocodiles and Tortoises have these organs fully developed and in active function for some time. This means that the embryonic renal system of these two groups of Reptiles is an important link between the renal system of other Sauropsida and Mammals on the one hand and that of the Anamnia (and especially Selachians and Amphibians) on the other. It also affords a proof that in primitive Reptiles the renal glands must, all their life long, have been connected with the cœlom.

In the ontogeny of the renal gland of Crocodilia and Chelonia we can follow the whole series of stages which gradually free it completely from the cœlom; all the three kinds of nephrostome are merely modifications of one and the same arrangement, and with the "glomus" and "glomerulus" may be looked at from the same morphological and physiological point of view, that is, their permanent connection with the cœlom. The same is true of the permanent kidneys (metanephros), which arise indirectly from the same rudiment, and are not to be regarded as anything else than a posterior and more lately developed portion of the primitive kidney.

The Müllerian duct of Crocodiles and Chelonians has as little to do with the pronephric duct, in its development, as in any other Vertebrate animal.

Development of the Reproductive System.*—Prof. J. Janošik's investigation of the early development of the reproductive organs in mammals has led him to conclude that if all were developed the result would be hermaphrodite organs, with internal testes and ovaries surrounding them. The same is true for the fowl and probably for other birds. The cells from which spermatozoa arise are descendants of those which are due to the primary proliferation of the germinal epithelium; the cells from which ova are formed are ontogenetically younger.

Structure of Nervous Cells.†—Dr. A. Coggi protests against drawing hasty conclusions about structure from artificially prepared specimens. He deals especially with some theoretical conclusions which Sig. Magini drew from his study of the electric lobes of *Torpedo*, These are not confirmed by the investigation of the living cells. Thus the karyoplasma does not always contract in the direction of the nervous

* SB. K. K. Akad. Wiss. Wien, xcix. (1890) pp. 260–88 (1 pl.).
† Atti R. Accad. Lincei—Rend., vi. (1890) pp. 236–8.

prolongation of the cell, but may contract in any direction according to the stimulus, and the position of the nucleus is variable.

Morphology of Blood-corpuscles.*—Mr. C. S. Minot distinguishes the blood-corpuscles of Vertebrates as red cells, white cells, and plastids; the last name is applied to the non-nucleated corpuscles of adult Mammals which are completely new elements, peculiar to the class, and not derived either from white or red corpuscles; they were first described by Schäfer, whose results have lately been confirmed by Kuborn. Their essential characteristic is that they arise intracellularly and by differentiation of the protoplasm of the vessel-forming cells.

The red cells have three chief forms, the primitive of which does not, perhaps, persist in any adult Vertebrate; the second form obtains in the Ichthyopsida, and the third in the Sauropsida. The author distinguishes (*a*) blood with single cells; that is the first stage in all Vertebrates, when the blood contains only red cells with a small quantity of protoplasm; (*b*) blood with two kinds of cells, red and white; the red cells have either a large, coarsely granulated nucleus as in the Ichthyopsida, or a small darkly staining nucleus as in Sauropsida and embryonic Mammals; and (*c*) plastid blood, without red cells but with white cells and red plastids; this is found only in adult Mammals.

B. INVERTEBRATA.

Parasites of Mola rotunda.†—Prof. Leidy reports a great number and variety of parasites from this Sunfish. Chief among them was the large Lernean, *Penella filosa*, which hung in great clusters from the root of the dorsal and other fins; they were from five to nearly seven inches long and had one to three inches buried in the flesh of the fish. To many of these were appended the barnacle, *Conchoderma virgatum*, and they were also more or less profusely covered with colonies of the Hydroid Polyp *Eucope parasitica*. The other Crustacean parasites were *Cecrops Latreillii*, *Læmargus muricatus*, and *Dinematura serrata*.

Gliding on the skin was the circular Trematode *Tristomum Rudolphianum*, and in the intestine was *Distomum pedocotyle* which appears to be new; the body is cylindrical, narrowest in front, with vertical bothria larger than the mouth and projecting in advance to an extent equal to the body. The soft, yellow liver of the fishes was throughout pervaded with the tape-worm *Anthocephalus elongatus*.

Mollusca.

a. Cephalopoda.

Notes on Cephalopods.‡—Dr. A. Appellöf commences with a description of a new genus of Œgopsida, which he calls *Chthenopteryx*; its fins consist of a series of muscular filaments, which are connected at their base by an extremely thin and transparent membrane. The apparatus for closing the mantle consists of a cartilaginous piece placed on either side of the base of the funnel, and having in the middle an extremely delicate groove; a cartilaginous ridge corresponding to this

* Anat. Anzeig., v. (1890) pp. 601–4.
† Proc. Acad. Philadelphia, 1890, pp. 281–2.
‡ Bergens Museums Aarsberetning for 1889 (1890) No. iii., 34 pp. and 1 pl..

groove is to be found on the inner side of the mantle. There are only two pairs of adductors of the funnel. The optic orifice is pyriform in shape. The single species, *C. fimbriatus*, has been found in the Mediterranean. This new genus has some remarkable peculiarities, but may be placed with the Ommatostrephidæ.

The author has had the opportunity of examining various specimens of *Veranya sicula*. In its chief characters this species agrees with most of the other Œgopsida, but there are some points which may be peculiar to it; such are the presence of two commissures between the visceral nerves, which have not been reported in any other Decapod; the position of the heart is rather octopod than decapod in character; in the feeble development of its musculature *Veranya* approaches the Cranchiidæ and Chiroteuthidæ.

Some observations are offered on *Loligo Alessandrini* of Vérany, which Dr. Appellöf places with *Calliteuthis;* the liver was seen to consist of one mass, which indicated its double nature by a shallow groove. The accessory is much more spacious than the true stomach, and has a distinct spiral twist. The heart is elongated in the transverse direction of the body, and is so curved that the tip from which the cephalic aorta arises looks forwards; the posterior aorta arises in the hinder margin of the heart; the efferent duct of the ink-bag is very short. *Calliteuthis reversa* Verrill is now for the first time recorded from the Mediterranean; it is a species of wide distribution, as it has been found on the North Atlantic coast of America and in New Zealand and Japan.

γ. Gastropoda.

List of Opisthobranchiate Mollusca of Plymouth.* — Mr. W. Garstang gives a complete list of the Opisthobranchiate Mollusca hitherto found at Plymouth; fifty-four species are, in all, recorded. With regard to the colour-changes in *Aplysia punctata*, which M. Vayssière attributes to the nature of the bottoms upon which they are found, the author remarks that the living *Aplysia* whose colour-changes he observed was kept under the same conditions for two months. The characters of the radula are discussed in great detail. All the known specimens of *Lomanotus* appear to belong to *L. genei*, notwithstanding the fact that some six specific names have been applied to them. Mr. Garstang gives a quantity of interesting information regarding many of the species which he catalogues.

Nervous System of Parmophorus australis.†—M. L. Boutan finds that three sets of nerves are given off from the ventral nervous mass of *Parmophorus;* from the lower surface nerves go to the foot only; from the sides others pass to the lower mantle, and between these there are nerves which pass directly to the mantle. It may, therefore, be justly concluded that the ventral nervous mass is both a pedal and a pallial centre. The author combats the views of those who regard *Fissurella* and *Parmophorus* as intermediate between the Lamellibranchiata on the one hand and *Chiton* and even worms on the other; the apparent symmetry of the adult is an acquired character, and the farther back we

* Journ. Marine Biol. Assoc., i. (1890) pp. 399–457 (2 pls.).
† Arch. Zool. Exper. et Gén., viii. (1890) pp. xliv.-viii.

trace the history of development the more do we find the primitive want of symmetry, while the larva is like that of normal Gastropods. It must not, however, be supposed that *Fissurella* and the allied forms are highly organized Gastropods; while they have become more differentiated in the symmetry of various organs, they have preserved indubitable signs of inferiority.

It may be concluded that the lower mantle or epipodium is of the same nature as the mantle, since the nerves which are supplied to it arise from the same parts of the centre as the nerves of the mantle. It may also be concluded that the two first ganglia of the asymmetrical centre are not limited to the upper part of the nerve-chain which furnished the nerves for the mantle and epipodium. If this be so, the groove which marks out two distinct and parallel parts in the nervous mass is not, as B. Haller supposes, an unimportant groove, but is of high morphological interest, as it indicates the point of union of the pedal and pallial centres. As the nervous system of *Fissurella* is very like that of *Parmophorus*, the conclusions may be applied to the former which are drawn from the latter.

That there is an ontogenetic and phylogenetic relation between *Parmophorus*, *Haliotis*, and *Fissurella*, is shown by the presence in the last of two nerve-rings in the mantle, which replace the pallial anastomoses seen in the two first.

The presence of the vestige of a coiled shell in the young of *Parmophorus* and *Fissurella* show that there is no affinity between these molluscs and the Lamellibranchs or the Chitons.

Nervous System of Cypræa.*—M. E. L. Bouvier, in consequence of some criticisms made by Dr. B. Haller in his recent memoir on *Cypræa*,† has re-examined the nervous system in *Cypræa arabica*. M. Bouvier has not been able to find the terminal ganglion in the first branchial nerve which has been described by his critic, but he has been able to trace the nerve itself and see it innervate the mantle; the nerve is quite large, and can be seen without any dissection. Similar answers are made to sundry other criticisms, and some few new details are added.

Development of a Solenogaster.‡—M. G. Pruvot has been able to follow out the development of a recently described species of *Dondersia*—*D. banyulensis*. The eggs are deposited a few at a time, and are covered with a delicate shell. Segmentation is unequal from the first; at the 8-stage there is one large blastomere at the nutrient pole, and seven small and equal blastomeres at the formative. Periods of repose alternate with periods of division. After twenty-four hours there appears a median corona of vibratile cilia, while two ciliated areæ appear at the cephalic pole and the point of invagination respectively. The embryo elongates and becomes divided by two annular constrictions into three segments. The cephalic segment is formed of two rows of ciliated cells; some of the cilia become longer than the rest, and one finally becomes much larger, and forms the terminal flagellum. The second segment or velum is formed of a single layer of cells, which have a single row of cilia: these grow and form the ciliated corona, the chief organ of

* Zool. Anzeig., xiii. (1890) pp. 717–20. † See this Journal, 1890, p. 704.
‡ Comptes Rendus, cxi. (1890) pp. 689–92.

locomotion. The third or pallial segment is formed of two rows of cells which are entirely covered by fine cilia. In a larva of 100 hours three imbricated spicules are to be seen on either side of the ventral line, still inclosed in their mother-cells. The spicules increase in number. The conical body elongates rapidly and becomes curved on its ventral surface, while the mantle is gradually reduced, and the embryo falls to the bottom, as the ciliated corona is unable longer to support it in the fluid.

Only one of the author's embryos passed safely through the critical period of metamorphosis, which is on the seventh day. This change consists in the casting off of almost the whole of the external envelope of the larva, that is to say, of the cells of the velum and the two rows that form the pallial lobes. Seven dorsal calcareous and slightly imbricated plates were observed in the surviving embryo.

Till the time of metamorphosis the larva has no mouth, and the endoderm forms a solid mass flanked on either side by solid rows of mesoderm, the origin of which has not yet been made out.

To sum up, the mode of segmentation is almost identical with that of *Dentalium* and certain Lamellibranchs; the mouthless larva, formed of three segments, has no known analogue, except among the Brachiopoda; the loss of the greater part of the ectoderm has been noted in *Polygordius*, and the tegumentary investment of the young Solenogastrid closely recalls that of young Chitons.

δ. Lamellibranchiata.

Primitive Structure of Kidney of Lamellibranchs.*—Dr. P. Pelseneer points out that it is the generally received doctrine that the structure of the renal organ of Lamellibranchs does not ally them to the lowest, but to the more highly developed representatives of the Prosobranchiata. This statement, however, is made on the results of the investigation of very specialized forms. When the more archaic representatives of the group, such as the Nuculidæ or Solenomyidæ, are dissected, a very different arrangement is found to obtain. In them each kidney forms a sac which is folded on itself in such a way as to have its two ends more or less approximated and directed forwards; one of these opens into the pericardium, and the other to the exterior. In no Protobranch does the sac extend as far backwards as the posterior adductor, and it does not communicate with its fellow. As to structure, the kidney has no internal fold or lamella, and no ramifications; it is an absolutely simple sac, with a large lumen. Its inner wall is formed by a uniform epithelial investment, extending from one extremity to the other, and having all its cells similar and secretory. This fact shows that, in the more specialized Lamellibranchiata, the terminal or postero-anterior branch of the kidney had not, as Rankin supposed, a primitively efferent function, but was originally secretory, like the whole of the gland. The arrangement which obtains in the Najidæ, for example, when the secretory formation falls on the antero-posterior branch, is a specialization.

From the point of view of structure there is a great resemblance between the protobranch Lamellibranchiata and the Fissurellidæ, for the

* Comptes Rendus, cxi. (1890) pp. 583-4.

renal organs of *Solenomya* and *Fissurella* are much more similar to one another than are those of the former and most Lamellibranchs, or of the latter and most Gastropods. The resemblance between the excretory organ of the Protobranchiata and that of the more primitive Rhipidoglossata is made still more complete by the fact that in the former (*Nucula*, *Leda*, *Yoldia*, *Solenomya*) the gonads open into the kidneys as in the Fissurellidæ, Haliotidæ, &c.; an arrangement known in only three of the higher Lamellibranchs.

Molluscoida.

α. Tunicata.

Origin of Test-cells of Ascidians.*—Dr. T. H. Morgan, who has examined various forms, describes especially the history of the test-cells in *Cynthia ocellata* and *Clavellina* sp. In the former the test-cells arise from follicular cells of the egg, which take up a more internal position; at the stage when the follicular cells are thus migrating two main sources of error may arise:—if the section passes near one end of the egg, when the convexity of the surface is so great relatively to the plane of the section that two or more layers of the nuclei of the follicle may appear in the same section; or an error may arise if the microtome knife does not cut the egg cleanly, but turns over part of the follicular zone. The author refers so constantly to his figures that we cannot trace with him the various stages in development. In later stages the test-cells do not seem materially to change either in number, size, or structure, but the follicular cells continue to increase in size and become much vacuolated. In young ova the follicular cells were found from surface views to have irregular outlines, and in general appearance to resemble peritoneal epithelial cells. Dr. Morgan's results agree essentially with those of Van Beneden and Julin, and are diametrically opposed to those of Davidoff.

β. Bryozoa.

Cyclatella annelidicola.†—M. H. Prouho gives an account of this organism. It was first seen by MM. Van Beneden and Hesse on the integument of a *Clymene*, and was by them regarded as a Tristomid, though its resemblance to a *Loxosoma* was noticed. Leuckart believed it to be a Bryozoon, and with him Nitsche agreed, while Schmidt upheld its Trematod character, though Van Beneden was converted by the arguments of Leuckart.

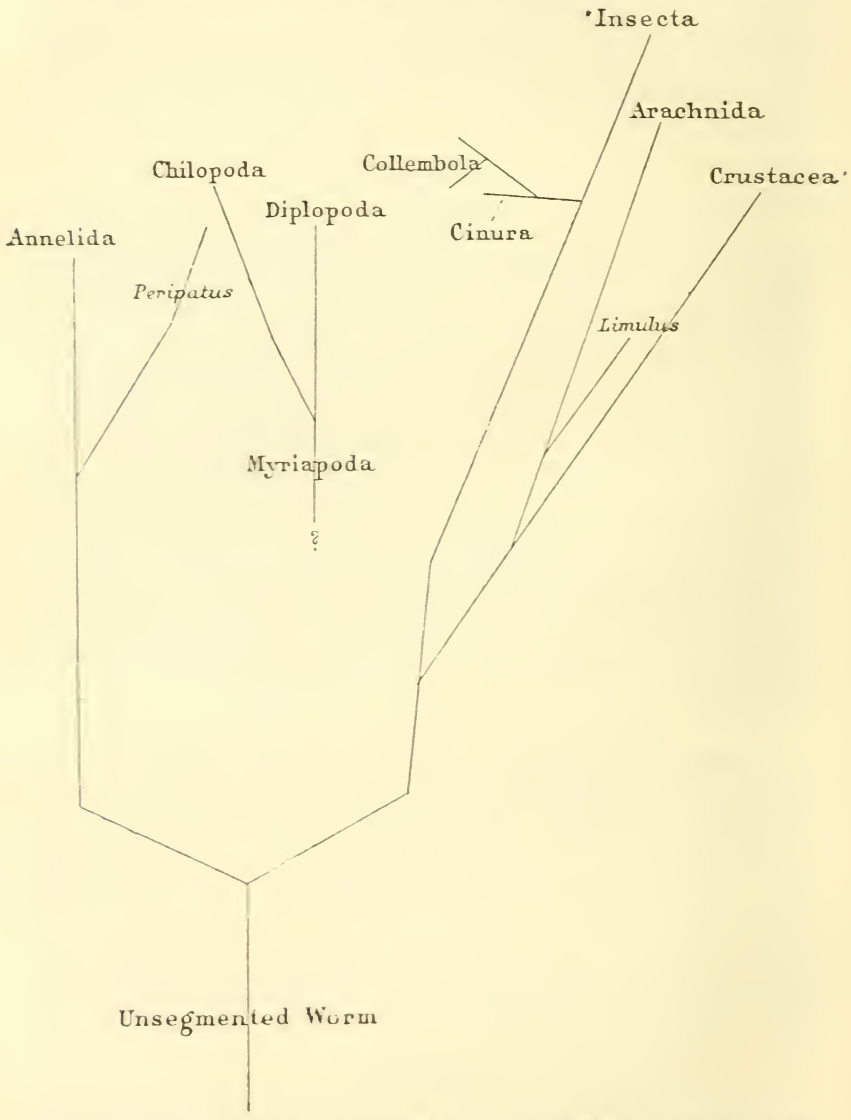
M. Prouho cannot doubt that it is a *Loxosoma*, although specifically different from any species yet described as belonging to that genus. It has the two lobes of the calyx greatly developed, and the other characters, none of more than specific value, are enumerated and discussed.

Arthropoda.

Relationships of Arthropods.‡—Prof. H. T. Fernald discusses the relationships of Arthropods. He commences with an account of the

* Journal of Morphology, iv. (1890) pp. 195–204 (1 pl.).
† Comptes Rendus, cxi. (1890) pp. 799–801.
‡ Stud. Biol. Lab. Johns Hopkins Univ., iv. (1890) pp. 432–513 (3 pls.).

anatomy of *Anurida maritima*, and has some notes on *Lepisma saccharina*. The probable characters of the ancestors of Insects are judged from the



evidence given by Palæontology, Anatomy, and Embryology, and the following summary is given of the characters of the "archentomon":—

Segmented, bilaterally symmetrical, divided (perhaps slightly) into head, thorax, and abdomen. On each thoracic and abdominal (?) segment

a pair of jointed legs; two pairs of wings (perhaps only dorsal lobes); a pair of antennæ and a pair of eyes; gnathites (three pairs) formed for biting. Body covered by a somewhat chitinous layer resting on a cellular one; alimentary tract straight, with its terminal portions lined by chitin; into its anterior end opened the ducts of a pair of secretory glands, and into its posterior portion several thread-like hollow tubes. Respiration effected by tracheæ. The circulatory system consisted of a dorsal vessel, narrowed in the thoracic region, and the nervous of a double supra-œsophageal ganglion, œsophageal cords, subœsophageal ganglion, and a segmentally placed series of ventral ganglia, joined by commissural bands. A fat-body at least partly occupied the body-cavity. Sexual organs paired, opening to the exterior by a median duct. Sexes distinct; animal terrestrial.

From the archentomon two or several trunks developed; one trunk divided into two limbs, one of which became the Cinura, which are only slightly modified from their ancestor; the other limb would represent the Collembola, and send branches in various directions. The other main trunk or trunks develope rapidly and in different directions, and represent the different groups of the higher Insects.

The Arachnida, Myriopods, and *Peripatus* are discussed, and the conclusion is come to that the first of those has no close relationships with the others or with the Hexapoda. The Crustacea seem to be separated from all except the Arachnida.

The author offers the phylogenetic diagram reproduced on the preceding page.

Experimental Researches on Locomotion of Arthropods.*—M. J. Demoor remarks that no observer has yet explained the theory of the production of the double step in Arthropods. The observation of the oscillations of the body and of the displacements of the centre of gravity has been greatly neglected.

He finds that the mechanical hexapod system of Insects is that of the double tripod, with alternate movements. Each tripod is formed by the anterior and posterior legs of one side, and the median leg of the other. The anterior leg is a traction lever, the posterior pushes, the middle supports. Oscillations take place in the horizontal, vertical antero-posterior, and vertical transverse planes. The terrestrial progression of walking Insects is always walking, in the physiological sense of the word.

The Arachnida are octopods; the four middle levers, which are essentially supporting, form on the ground a basis of support triangular in form. The anterior limbs draw, the posterior push. The first and last limbs of one side act simultaneously. Of the Crustacea, some species walk forwards, and some laterally. In the former the hexapod or octopod mode of locomotion is entirely similar to that of Insects or Arachnids. In the latter the limbs are indifferently organs of traction or propulsion. No anatomical differentiation nor any functional constancy characterizes the different appendages; the mechanical system is octopod; there is no regularity in the alternation of the limbs of either side.

In all walking Arthropods which M. Demoor has examined the centre

* Comptes Rendus, cxi. (1890) pp. 839-40.

of gravity leaves the base of support at each step, so that the general definition of walking applies to the locomotion of these organisms. There is a causal relation between the lateral walking of some Crustacea, and the globular form, the insertion of the limbs far from the axis, and the general conformation of these creatures. The physiology of movement of Crabs confirms the theoretical data, and requires a median insertion and a functional horizontality of the limbs. The foot of Crustaceans is defective as a walking organ, owing to the articulation of the carpopodite with the ischiopodite; this articulation is necessary for the production of the functional horizontality of the limb. The octopod walk of Scorpions is less perfect than hexapod progression, which in Insects is, from a mechanical point of view, very perfect.

Is the Ommatidium a Hair-bearing Sense-bud? *—In answer to this question Prof. W. Patten states that he has come to the conclusion that the convex eye of Arthropods is a group of hair-bearing sense-buds. He finds hair-like pseudocones over the cone-cells of *Belostoma*, *Tabanus* and *Vespa*, and he considers his suspicion that the ommatidia are modified hair-bearing organs is fully confirmed by the fact that, in the young pupæ of *Vespa*, the first corneal cuticula is actually provided with hair-like spines unquestionably formed by the hardening of the outer ends of the pseudocones. This spine-bearing cornea is soon shed, and a facetted one formed; each facet, which is, in the main, the product of two newly formed cornea-forming cells, often contains, in its centre, the remnants of an ommatidial spine. If the ommatidia are hair-bearing sense-buds, we ought to find some resemblance between isolated hair-cells and retinophoræ and isolated hair-cells acting as rudimentary ommatidia. This seems to be really the case, for the isolated hair-cells of *Vespa* are beyond all question double cells, and they contain a coiled canal which the author believes to be continuous with a nerve-tube. After the first pupal moult the larger component cell forms a long protoplasmic process which is finally converted into one of the bristles so abundant near the eyes. These double hair-cells resemble the retinophoræ of Molluscs and Arthropods in their axial nerve-canals, the imperfect union of their twisted component cells, and in the position, size, and colour of their nuclei. Moreover, hair-cells have been found between the ommatidia in the convex eyes of *Aphis*, *Vespa*, and *Belostoma*, and in all cases the cells were surrounded by a layer of pigment, so that they bore a striking resemblance to very simple ommatidia, and probably functioned as such.

The author does not think it necessary to assume, as is usually done, that the adult ancestors of animals with vesicular eyes had eyes in progressive stages of invagination. He thinks we may safely assume that primitive sense-organs, ganglia, &c., have been formed, phylogenetically, by the telescoping of individual epithelial cells; this process, when repeated ontogenetically, gives rise to invaginations, for invagination probably occurs only in compound sense-organs, and then as an incidental result of the rapid inwandering of ganglion-cells, which, causing an enlargement of the inner surface of the sensory layer, gives rise to a warping of the whole organ.

* Anat. Anzeig., v. (1890) pp. 353–9 (4 figs.).

a. Insecta.

Metamerism of Insect's Body.*—M. A. Lameere has a preliminary notice of the results of his study of the development of *Phyllodromia germanica*. He supports the view of Savigny that the order of buccal appendages is, mandibles, maxillæ, labium, against that of Meinert who puts the labium first and the mandibles last. Only four pairs of enterocœlic cavities are developed in that part of the embryo which goes to form the head; one does not correspond to the eyes, but the first bears the antennæ, and the succeeding the three buccal appendages. There is, in addition, an unpaired anterior cavity which corresponds to the labrum, and represents the medio-ventral chamber which causes the bilateral symmetry of Cœlenterates. M. Lameere is led to the conclusion that there are no preoral appendages in Insects, and that, from every point of view, the antennæ correspond to the cheliceræ of Arachnids and the antennulæ of Crustacea. In an early stage all the abdominal segments carry appendages, but the first and last only persist; the latter forms the cerci of the adult, the former becomes of considerable size, and then undergoes an enlargement at its free end, becomes detached and falls into the amnion. As there are ten segments in the embryonic abdomen, three in the thorax and four in the head, the whole number of somites in an insect's body is seventeen.

Hooked Joint of Insects.†—Herr A. Ochler has a memoir on the hooked joint of the feet of Insects. He considers that the hooks ought to be regarded as setæ modified for definite objects. The joint, in structure and function, belongs to one of two chief types; there is a two-hooked tarsal joint with or without organs of attachment, or it is one-hooked. The former is divisible into three subtypes: (*a*) with an unpaired median fixing lobule, (*b*) with two outer lateral fixing lobes, (*c*) with two fixing lobes below the hooks; the latter chief type is either a climbing or a clasping foot. The amount of movement possessed by the hooks is limited, and what there is, is effected by means of an elastic membrane and the exterior plate. The "extensor sole," which is always present in Insects with an unpaired median fixing organ, is to be regarded as a modification of the extensor seta. The extensor plate is an organ peculiar to Insects. The fixing organs are modified outgrowths of the integument. The tarsal margin is adapted to the function of the hooked joint. In ectoparasitic flies the fixing lobes are well developed. The so-called pressure-plate of Dahl is only a movably articulated skeletal supporting plate for the median fixing lobule.

Live Oak Caterpillar.‡—Writing in 'Zoe,' Mr. H. H. Behr points out how this species (*Phryganidia californica*) is indirectly protected by the English sparrow; some years ago it was thought to be a great prize by entomologists, but has lately become more common. Though four generations would arise in one summer, the live oaks on which they lived were not endangered, for various insectivorous birds, and especially a species of titmouse, ate the eggs and the caterpillars. But the sparrow,

* Bull. Soc. Belge de Micr., xvii. (1890) pp. 2–9.
† Arch. f. Naturgesch., lvi. (1890) pp. 221–62 (2 pls.).
‡ Amer. Natural., xxiv. (1890) pp. 685–6.

when introduced, drove away the titmouse, and now the leaves of the live oak disappear four times a summer, some trees succumbing and others surviving.

Adhesive Organs on the Tarsal Joints of Coleoptera.* — Prof. P. Pero has made a detailed study of the microscopic organs of adhesion which are found on the tarsal joints of Coleoptera, especially in the lower families of this order. In Longicorn beetles, Curculionidæ, and Chrysomelidæ they are very well developed, and the author believes them to be efficient. Their evolution he explains by natural selection. But in Carabidæ and Cantharidæ (*Idrocanthari*) they are usually restricted to the first pair of legs in the males only, and have been interpreted by Camerano as evolved by sexual selection, and by Zimmermacher as organs for copulatory adhesion. These interpretations are denied by Prof. Pero, who maintains that in the families mentioned the structures are rudimentary organs entailed on the males only.

Blood of Meloe and Function of Cantharidine in Biology of Vesicating Coleoptera.†—M. L. Cuénot confirms the view of Leydig that the fluid ejected by a vesicating coleopterous Insect when it shams death is blood; this escapes in somewhat viscous yellow drops from the tibio-tarsal articulations. Magretti and Beauregard are therefore wrong in regarding the fluid as a special excretion. The chemical constitution of this blood is much the same as that of caterpillars; it has cantharidine dissolved in it, and the function of this compound is undoubtedly a defensive one. It is excessively disagreeable to other Insects.

Tongues of British Hymenoptera Anthophila.‡—Mr. E. Saunders gives descriptions and figures of the tongues of British anthophilous Hymenoptera. In all the genera the cibarial apparatus is arranged on the same general plan as in *Apis*, the structure of which was described by Mr. T. J. Briant; but it varies considerably in details, both as to the shape and the relative proportions of its component parts. After a general description the details of the different genera are described. Mr. Saunders states that "it is to the beautiful preparations of Mr. Enock that all the merit of this paper is due."

Life-history of Lyda.§—Dr. K. Eckstein describes the life-history of this wasp whose larvæ often do so much damage in pine forests. In early summer the females of *L. pratensis* lay their eggs on the tips of the pine needles, usually not more than one on a double leaf. The hatched larva spins a loose web, and there are usually several of these on one twig. The inmates devour the leaves, but without abandoning their shelter, which they renew as they move from leaf to leaf. After several moults they lose their power of spinning, and the colour, hitherto bright, becomes ochreous or dull green. They fall to the ground, and soon bury themselves 10–12 cm. in the earth. There they lie quiescent, slightly shrivelled, but with leathery skin and abundant adipose tissue. They do not pupate, but remain dormant for two years. The whole

* Atti Soc. Ital. Sci. Nat., xxxii. (1889) pp. 17–64 (4 pls.).
† Bull. Soc. Zool. France, xv. (1890) pp. 126–8.
‡ Journ. Linn. Soc.,' xxiii. (1890) pp. 410–31 (8 pls.).
§ Zool. Jahrb., v. (1890) pp. 425–36 (1 pl.).

life-history—of *L. pratensis* and *L. hypotrophica* at least—thus occupies three years.

Halteres of Diptera.*—Herr E. Weinland has a long and detailed paper on the "balancers" of Diptera. The balancer is modified from a hindwing and has in its interior canals, which correspond to the veins of a wing; it is of no use as an organ of flight. It is capable of a large number of various movements which are rendered possible by a second joint which is to be found at its base, and in which the proper thoracic muscles take no part. It can bring about differences in the direction of the flight of an Insect in the vertical plane; if the balancers act unequally there is a change in direction.

The sensory organs formed of variously constructed papillæ which are found at the base of the halteres are the means by which movements are perceived. The movement of the organs when the insect is not flying has for its object the preservation of the equilibrium of the body.

A new Cecidomyia.†—Dr. F. Thomas describes the life of *Cecidomyia pseudococcus* sp. n., which has this special interest, that the larva is not errant, but keeps to one position on the leaf of *Salix caprea* and yet forms no gall. The absence of a gall may be due to some constitutional peculiarity of the species, e. g. in its secretion, but it is more probably an illustration of the general fact that galls are formed only on leaves which are still growing, for this species is too slow in developing to be able to attack the young willow leaves.

Herr E. H. Rübsaamen ‡ gives a careful description of the pupa and imago of this new species.

Host of Hypoderma lineata.§—Prof. F. Brauer publishes the discovery which the late Dr. A. Handlirsch made of the host of *Hypoderma lineata* Villers. He explains how the insect was traced to cattle, contrasts it with *H. bovis*, and gives some interesting information about the habits of these pests. It seems that the larva of *H. bovis* found in the skin of cattle is not strictly the first stage, but that there is a preliminary larval form *in ovo* before deposition is effected.

Terminal Segment of Male Hemiptera.‖—Dr. D. Sharp describes this in twenty-nine species. It forms a chamber widely open externally and contains the following structures:—(1) the part of the male organs through which pass the membranous structures connected with the ejaculatory duct; (2) the termination of the alimentary canal which is free and very mobile, and forms a sort of tail; (3) some accessory pieces of appendages, a lateral on each side and an inferior single piece. The differences in species systematically allied are extraordinarily great, but no variation was observed within the same species. "The æsthetic aspect of the arrangement in many of the higher species is very remarkable," but Dr. Sharp does not attach any special biological importance to it. The structures are not in any way modified for clasping; they protect sensitive parts from pressure, exclude parasites, direct the move-

* Zeitschr. f. Wiss. Zool., li. (1890) pp. 55–160 (5 pls.).
† Verh. K. K. Zool.-Bot. Ges., xl. (1890) pp. 301–6.
‡ T. c., pp. 307–10 (1 pl. shared by the two papers).
§ Verh. K. K. Zool.-Bot. Ges., xl. (1890) pp. 509–16 (3 cuts).
‖ Trans. Entomol. Soc. Lond. (1890) pp. 399–427 (3 pls.).

ment of the true intromittent organs, and probably alter the pressure on the ejaculatory canal.

Spermatogenesis in Locustidæ.*—M. A. Sabatier has studied the development of the spermatozoa in *Locusta viridissima*, *Decticus albifrons*, and *D. griseus*. He finds that a vesicle becomes formed in the protoplasm, and that it is placed near the caudal pole; he calls it the protoplasmic vesicle. This vesicle grows and elongates and its walls become invested internally with chromophilous granules. When it is fusiform in shape and takes stains freely it forms what has been regarded as the head of the spermatozoon. The grains of nuclein in the nucleus become vesicular and form a group of vesicles which fuse, lose their affinity for the nuclear stains, and form an anchor-shaped head-covering. The degeneration of the nucleus *qua* nucleus is, therefore, one of the principal characters in the spermatogenesis of the Locustidæ. The protoplasm of the cell elongates in the form of a tail, in the axis of which appears a filament which forms the tail of the spermatozoon.

γ. Prototracheata.

New Species of Peripatus from Victoria.—Mr. A. Dendy writes to us to say that he regards *Peripatus insignis* mentioned in our note † as a good species, and as distinct from the specimens which, after some trouble, he recognized as examples of *P. leuckarti*. Several specimens of *P. insignis* have been found at Macedon.

δ. Arachnida.

Structure of Nerve-centres of Limulus.‡—M. H. Viallanes describes the minute structure of the nerve-centres of the King-Crab. The proto-cerebrum is composed of relatively small fibrous nodules and is partially invested by a cortex of large unipolar cells. The nerve for the compound eye is not directly connected with the corresponding cerebral lobe, but intermediately and by a structure which is comparable in its essential points to the optic lobe of Insects and Crustaceans. With each of the proto-cerebral lobes there is connected an organ which, from its anatomical relations and histological structure, may be compared to the pedunculated body of Insects. In *Limulus* this pedunculated body is arborescent in form, its upper extremity dividing dichotomously into a large number of branches. These last, which end in truncated extremities, are entirely invested by a thick cortex of small cells; they are very poor in protoplasm, stain deeply, give off very fine fibrils, and, in a word, are exactly comparable to the elements which form the cellular investment of the similar body in Insects. The pedunculated body of *Limulus* is extraordinarily developed, and is larger than in any known Arthropod, for it forms at least 99/100 of the total mass of the brain.

The hinder brain is composed of a pair of nervous masses which give origin to the nerves of the cheliceræ, and are connected with one another by a transverse peri-œsophageal commissure. This latter is invested by a very resistant fibrous sheath. The lateral parts of the

* Comptes Rendus, cxi. (1890) pp. 797–9.
† See this Journal, 1890, p. 453.
‡ Comptes Rendus, cxi. (1890) pp. 831–3.

nerve-collar are formed by five pairs of ganglionic centres which innervate the five pairs of foot-jaws. The hinder part of the nerve-collar is formed by the very close fusion of two pairs of ganglionic centres, the second of which innervates the operculum.

ε. Crustacea.

Amœboid Cells in Crab's Blood.* — Prof. G. Cattaneo describes the granular and hyaline cells in the blood of *Carcinus mænas*. The two kinds of cells are simply different physiological states of the same set of elements. The normal form is that with localized polar or bipolar pseudopodia, but this may degenerate into a radiating amœboid phase, or the amœboid cells may unite abnormally in plasmodia. The various phases are compared with those of Myxomycetes. With some difficulty Cattaneo was able to demonstrate that the cells may absorb particles in phagocytic fashion. He describes their behaviour in water, when undergoing desiccation, in relation to oxygen, carbonic acid, and chemical reagents, and his results are like those of Graber and Frommann. A ciliated Infusorian, *Anophrys maggii*, is sometimes an abundant parasite in the blood.

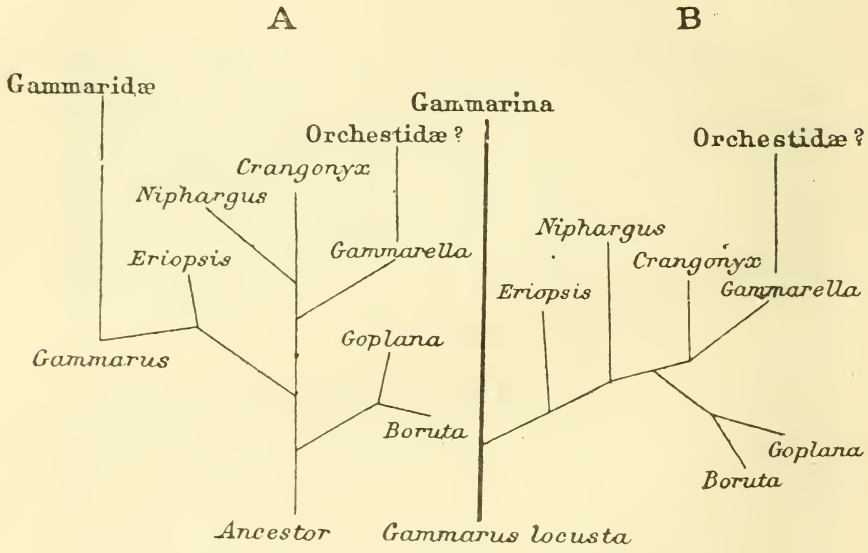
Excretory Apparatus of Palinurus, Gebia, and Crangon.†—M. P. Marchal, in continuation ‡ of his studies on the excretory apparatus of Crustacea, describes those of *Palinurus vulgaris* and *Crangon vulgaris*. With regard to the internal structure of the organ in *Gebia* we may note that there is a sacculus with a central cavity from which are given off numerous ramifications which pass into the reticulated tissue of the surrounding labyrinth; this tissue is very dense and the glandular lacunæ in it are extremely numerous. The clear portion is formed by a less dense glandular reticulum, and the spaces become progressively larger near the excretory tubercle, with the orifice of which one space communicates by means of a fine canaliculus. *Crangon* has, like *Palæmon*, a large unpaired bladder lying above the stomach; it has numerous lobes which make their way between the different organs. In a preceding notice the author spoke of the mobile piece which carries the excretory orifice in *Maia* as representing the excretory tubercle of the Macrura, but he is now convinced that it corresponds to the whole joint which carries this tubercle. In other words, it is the homologue of the first joint of the antennæ of the Macrura.

Palæmonetes varians.§—Mr. W. F. R. Weldon has examined nearly a thousand specimens of *Palæmonetes varians* at Plymouth, and finds a considerable amount of variation in the characters of the rostrum. There is at Plymouth a race which approximates in its habits to the races of Southern Europe, but in its development, at least, completely resembles those northern forms from which it is probably descended.

Three Subterranean Gammaridæ.‖ — Dr. A. Wzesniowski has published a German translation of his Polish essay on these Amphipods,

* Atti Soc. Ital. Sci. Nat., xxxi. (1889) pp. 231-66 (1 pl.).
† Comptes Rendus, cxi. (1890) pp. 580-2. ‡ See this Journal, 1890, p. 719.
§ Journ. Marine Biol. Assoc., i. (1890) pp. 459-61.
‖ Zeitschr. f. Wiss. Zool., l. (1890) pp. 600-724 (6 pls.).

in which he discusses their characters in the greatest detail. We have only space for the conclusions which he summarizes in two phylogenetic tables; he thinks it almost certain that the primitive ancestor was marine.



Sexual Dimorphism of Copepoda Ascidiicola.* — M. E. Canu points out that there are very considerable differences between the sexes in these Crustacea; the males have rarely been observed, and when they have they have ordinarily been described as distinct species. It is necessary to follow the various stages before defining species. He gives a special account of *Enterocola fulgens*, which is often found on *Polyclinum succineum*.

Test-gland of Freshwater Copepoda.†—M. J. Richard has a preliminary notice of his researches on the so-called test-gland of Copepods, in which he makes some additions to the knowledge acquired for us by Prof. Claus. He has examined the organ in a number of forms.

Polar Bodies of Balanus.‡—Dr. B. Solger states that he has lately been able to observe the formation of both polar globules in a large number of eggs of *Balanus improvisus*. During the process of constriction of the second the first lay on the outer surface of the egg-membrane. An ovarian lamella was fixed in chrom-acetic acid and cut into a series of sections. After staining with hæmatoxylin a large number of eggs exhibited, near the blunt pole, a well-marked spindle, which on account of its size, appeared to be the first. Further details are given, and it is

* Comptes Rendus, cxi. (1890) pp. 757–9.
† Bull. Soc. Zool., xv. (1890) pp. 113–8.
‡ Zool. Anzeig., xiii. (1890) pp. 607–9.

stated by the author that his observations agree very well with those of Nusbaum on *Pollicipes*, a genus of Lepadidæ which, in the opinion of Gerstaecker, is most nearly allied to the Balanidæ.

Vermes.

a. Annelida.

Epithelial Fibrillar Tissue of Annelids.*—M. E. Jourdan justly remarks that one often meets in Invertebrates with tissues which it is very difficult to refer to the types which we have been in the habit of observing in the organs of higher animals. The Annelids are particularly remarkable from this point of view, and the subcuticular epithelial layer often presents appearances which differ from those of ordinary epithelia.

In the proboscis of Glycerids the author has observed an epithelial layer which is represented by irregularly arranged nuclei set in the midst of a stroma of small fibres. These fibrils are easily distinguished from the muscular fibres of the contractile sheaths of the proboscis; nor can they be regarded as connective tissue. The only possible interpretation is that the fibres are nervous, although it is, *à priori*, difficult to suppose that they have a nervous function. It is probable that the stellate connective tissue described by Claparède in tubicolous Annelids belongs to the same group.

Chætopterus.†—M. J. Joyeux-Laffuie has prepared a monograph of this genus, the new points in which he summarizes in a somewhat novel fashion. The cephalic and buccal segments are distinct; there are eleven segments in the superior region of the body; the twelfth and thirteenth segments are characterized by the possession of pediculate suckers, ventral in position and of assistance in enabling the animal to adhere to the inner wall of its tube; the number of segments of the lower half is discussed, and the structure of the integuments described. It is well known that the mucus of *Chætopterus* is luminous, but the author finds that the contents of the glands, so long as they are contained in the cellular envelope, are not so. The diverticula of the general body-cavity are described, and additions are made to our knowledge of the musculature. The nerve-ganglia and the commissures that unite them with the nerves given off from them are described in great detail. The only sensory organs are the tactile and optic.

After dealing with the organs in order M. Joyeux-Laffuie describes the commensals of the worm, and states that the Bryozoon which he called *Delagia chætopteri* should be known by the older name of *Hypophorella expansa*. The only properly known species of the genus is *C. variopedatus*.

A new Alciopid.‡—Dr. C. Apstein describes *Vanadis fasciata* sp. n., a new Alciopid found during the cruise of the 'Galathea' in the North Pacific. It differs from the other numerous species of *Vanadis* chiefly in the abundance, irregular distribution, and large size of the

* Comptes Rendus, cxi. (1890) pp. 825–6.
† Arch. Zool. Expér. et Gén., viii. (1890) pp. 245–60 (6 pls.).
‡ Zool. Jahrb., v. (1890) pp. 543–5 (1 pl.).

"black glands," as also in the characters of the antennary-cirri and parapodia.

The Work of Earthworms on the African Coast.—The 'Kew Bulletin' * of October last contains a report by Mr. Alvan Millson, the Assistant Colonial Secretary of Lagos, on Yorubaland, the native territory adjacent to Lagos. After describing the wasteful system of cultivation employed by the natives and the wonderful rapidity with which the soil recovers from it, he says the mystery is solved in a simple and unexpected manner during the dry season. The whole surface of the ground beneath the grass is seen to be covered by rows of cylindrical worm-casts. These vary in height from 1/4 in. to 3 in., and exist in astonishing numbers. It is in many places impossible to press a finger upon the ground without touching one. For scores of square miles they cover the surface of the soil, closely packed, upright, and burned by the sun into rigid rolls of hardened clay. The rains ultimately break them down into a fine powder, rich in plant-food and lending itself easily to the hoe of the farmer. On digging down the soil is found to be drilled in all directions by a countless multitude of worm-drills, while from 13 in. to 2 ft. in depth the worms are found in great numbers in the moist subsoil. Having carefully removed the worm-casts of one season from two separate square feet of land at a considerable distance from one another, and chosen at random, Mr. Millson found the weight to be 10¾ lb., in a thoroughly dry state. This gives a mean of over 5 lb. per square foot and a total of not less than 62,233 tons of subsoil brought to the surface on each square mile of cultivable land in the Yoruba country every year. This work goes on unceasingly year after year, and to the untiring labours of its earthworms this part of West Africa owes the livelihood of its people. Where the worms do not work the Yoruba knows that it is useless to make his farm. Estimating one square yard of dry earth by 2 ft. deep as weighing half a ton, there is an annual movement of earth per square yard of the depth of 2 ft., amounting to not less than 45 lb. From this it appears that every particle of earth in each ton of soil to the depth of 2 ft. is brought to the surface once in twenty-seven years. It seems more than probable that the comparative freedom of this part of West Africa from dangerous malarial fevers is due, in part at least, to the work of earthworms in ventilating and constantly bringing to the surface the soil in which the malarial germs live and breed. From specimens which Mr. Millson has sent home it appears the worm belongs to a new species of the genus *Siphonogaster*.

Trigaster and Benhamia.†—Dr. W. B. Benham has altered his conclusion that *Benhamia* of Michaelsen is synonymous with *Trigaster* Benham. They are, perhaps, both subgenera of *Acanthodrilus*, with which (and with *Deinodrilus*) they have in common the following characters—The nephridia are in the form of a network; there are two pairs of coiled cylindrical prostates in somites xvii. and xix., and there are two pairs of spermathecæ. In *Trigaster* the clitellum is exceedingly long and extends over somites xiii.–xl.; in *Benhamia* it

* 'Bulletin of Miscellaneous Information,' 1890, pp. 243–4.
† Ann. and Mag. Nat. Hist., vi. (1890) pp. 414–7.

occupies at most eight somites; in the latter there are two, and in the former three gizzards; *Trigaster* has no calciferous glands, its spermathecæ are globular and without appendages; there are no penial setæ and no dorsal pores. *Benhamia*, on the other hand, has calciferous glands, the spermathecæ are ovoid, and have appendices to their narrowed ducts; there are penial setæ in special sacs, and some species, at any rate, have dorsal pores. Only one species of *Trigaster* is known, but there are already eight of *Benhamia*.

Heliodrilus.*—Mr. F. E. Beddard has a preliminary notice of a new genus of Eudrilidæ, which he calls *Heliodrilus;* it has some resemblance to the lately described genus *Hyperiodrilus*, and, like it, it comes from Lagos, West Africa. There are six gizzards—one to a somite—at the junction of the œsophagus with the intestine.

Development of Leeches.†—Dr. R. S. Bergh has a preliminary notice of the results of his investigations on the formation of layers in the germ-stripes of Leeches. In *Clepsine* the cell-rows are formed in the same way as in the earthworm; of the four more superficially placed rows of cells, those which lie nearest the median line (I.) go to form the ventral chain, and may consequently be called, with Whitman, the neural row; the three more lateral rows (II.–IV.) form the layer of circular muscles, and may, therefore, be called collectively the outer muscular plates; they have no relation to the formation of the nephridia. The deeper cell-row forms the so-called mesoderm, whence arise the blood-vessels, longitudinal muscles, loops of the nephridia, &c.

Matters are more complicated in the Leeches with jaws, for, as is well known, the primitive epidermis is lost and replaced by a new and permanent one. This new epidermis consists of the descendants of the three lateral primitive cells; in these, cell-divisions take place in various planes, and not only from before backwards, but also from right to left. In this way the germ-stripes increase in length and breadth, but do not give rise to any new layers. There are, however, other cell-divisions, which pass obliquely to the surface; by these divisions some cells become separated from the superficial layer. These multiply, extend in length transversely to the longitudinal direction of the germ-stripe, and so form the circular musculature; the superficial layer of the primitive cell-rows II.–IV. continue to grow and give rise to the permanent epidermis. The row (I.) nearest the median line here again forms the ventral chain; it thickens and fuses with its fellow of the opposite side; at first in a segmental manner in those regions which correspond to the later ganglionic parts. In the commissural parts they remain for some time distinct, and as the permanent epidermis is not yet formed, and there is no "mesoderm," there is at this stage a step-ladder-like appearance. So far as the author can see, some cells of the primitive nerve-cell-plexus take part in forming the ventral chain.

The looped parts of the nephridia are formed from derivatives of the more deeply placed cell-row, but the epithelium of the contractile terminal bladders are invaginations of the permanent epidermis; the nephridia of the earthworm have nothing homologous to these terminal bladders.

* Zool. Anzeig., xiii. (1890) pp. 627–9.

† T. c., pp. 658–60.

American Terrestrial Leech.*—Mr. S. A. Forbes calls attention to a hitherto unnoticed species of terrestrial leech occurring commonly in Illinois, where it is found in moist earth. When first found it was regarded by Prof. Verrill as identical with his *Semiscolex grandis*, but is certainly distinct from it, and may be called *S. terrestris* sp. n. We may suggest that this hybrid generic name be altered to *Hemiscolex*. Contracted spirit specimens have a length of 7 in., are 3/4 in. wide, and 3/8 in. deep. The colour is sooty drab varying to plumbeous black, and rather lighter beneath; a well-defined darker median longitudinal stripe is almost invariably present. There is no external trace of segmental papillæ. In all there are one hundred and four annuli. The eyes are ten in number; the male sexual orifice is on the twenty-eighth entire annulus, in the female on the thirty-third. The three maxillæ are rudimentary, and have an ill-defined armature of teeth. The only known food of this leech consists of earthworms of various genera, and these it swallows entire. Like the earthworm, this creature probably penetrates to considerable depths during the dry weather of midsummer.

Anatomy of Sipunculus Gouldi.†—Mr. E. A. Andrews gives a full account of the anatomy of *Sipunculus Gouldi*, which agrees closely with that of *S. nudus;* it is also sufficiently similar to that of *Phymosoma* as to indicate the fundamental identity of the two genera in all but secondary characters. The body-wall of *S. Gouldi* has, however, a less specialized epidermis than the other Sipunculid, while its glandular bodies are essentially identical with those of *Phymosoma*. The peculiar arrangement of the gland-cells described by Andreæ in *S. nudus* seems, to the author, to be due to poor preservation.

The tentacle-like processes about the mouth may be regarded as branchiæ physiologically, if not, also, morphologically, for a rapid circulation of corpuscles takes place in them; the dorsal blood-sac is not merely a reservoir for blood in introversion, but must also serve as a conveyor of respiratory gases to the liquid of the body-cavity, and furnish an important aid to the thick body-wall. The position of the cilia on the concave oral surfaces and their arrangement along radiating oral grooves suggest that the branchiæ also serve as means for bringing currents of water (and food) into the mouth. The statement that the cilia are on the outside surface seems to be an error due to the study of invaginated specimens, in which the positions of the branchial surfaces are apparently inverted.

The author has been able to demonstrate the presence of a nerve-plexus in the walls of the digestive tract; this is continuous with that of the body-wall at the anus. The digestive tract is divided into more numerous regions than have been hitherto recognized. The structure of the ciliated groove of the intestine suggests a secretory function, and at the same time a use as a conduit from one region to another.

The author has already ‡ described the structure of the reproductive organs, and he thinks that the arrangement which obtains may be taken

* Amer. Natural., xxiv. (1890) pp. 646-9.
† Studies Biol. Lab. Johns Hopkins Univ., iv. (1890) pp. 389-430 (4 pls.).
‡ See this Journal, 1889, p. 518.

as characteristic of Sipunculids ; a review of the opinions and statements of earlier investigators into the subject is now given.

Mr. Andrews sees nothing in the adult Sipunculid that may not be explained on the assumption of lost metamerism ; even the genital organs suggest a derivation from those of the Polychæta, with which they very closely agree in structure and fate ; their attachment to the posterior side of a septum may now be indicated by their attachment to the retractors.

β. Nemathelminthes.

Nematodes of Mammalian Lungs and Lung Disease.*—Herr A. Mueller has, in a convenient manner, brought together and added to our knowledge of round worms infecting the lungs of Mammals. Twenty-five species of mammals are known to be so infected, among which are Man, the Dog, the Fox, the Hare and Rabbit, the Pig and Ox ; sheep suffer most from these parasites, the most common of which is *Strongylus filaria*, which is found in eight species of Ruminants. Great care has been given to the description of the species of *Strongylus*.

Allantonema and Diplogaster.†—Dr. v. Linstow remarks that he can add another to the several cases which prove that a division into free-living and parasitic Nematodes does not accord with known facts. He has received some specimens of *Tomicus typographus*, which had in its body-cavity a large *Allantonema ;* the larvæ are very active, and make their way into the intestine whence they escape on to the back of the beetle, where they live between the elytra and wings, or between the wings and the surface of the body. Passing thence into damp earth, they become sexually developed Nematodes in ten days. They move about actively. There are six setæ, 0·005 mm. long in the head, and internally to them are six shorter setæ, which surround the mouth. The male is 0·84 mm. long, and 0·021 mm. broad ; the female is 1·03–0·97 mm. by 0·029 mm. If one were to find these Nematodes without knowing whence they came, they would be placed in the genus *Diplogaster*, and the author proposes for this new species the name of *Allantonema diplogaster*. On returning to the beetle they pass into the hermaphrodite stage.

γ. Platyhelminthes.

Enantia spinifera.‡—Prof. L. v. Graff describes *Enantia spinifera* as the representative of a new family—Enantiidæ—of Polyclads, which may be thus defined :—Body oval, smooth, without sucker or tentacles. Mouth near the anterior end, immediately behind the brain. Pharynx bell-shaped, directed forwards. There is no anterior median branch of the enteron, and the enteric branches anastomose. Male reproductive apparatus simple, with a muscular seminal vesicle directed forwards, placed directly behind the pharyngeal pouch, and opening there. Female reproductive apparatus opens a short distance behind the male, and has

* Deutsch. Zeitschr. f. Thiermed. u. Vergl. Path., xv. (1889) pp. 261–321 (4 pls.). See Centralbl. f. Bakteriol. u. Parasitenk., viii. (1890) pp. 706–8.

† Centralbl. f. Bakteriol. u. Parasitenk., viii. (1890) pp. 488–93 (6 figs.).

‡ Mittheil. Naturwiss. Ver f. Steiermark, xxvi. (1890) pp. 1–16 (1 pl.).

a well-developed bursa (accessory vesicle). Four optic aggregations in the cerebral area, but no eyes on the margin of the body.

This form, which is distinguished from all known species by the presence of marginal chitinous spines, was found at Trieste, and was noticed but not fully described by the author thirteen years ago. The largest of the eight specimens found measured 25 by 12 mm., but the thickness of the body is only 0·5 mm. The spines lie rather on the periphery of the dorsal surface than on the margin of the body; they are absent from the anterior fourth, but are closely packed on the rest; some are smaller than the rest and will obviously replace them; the largest spines are found on the last third of the body, and project not more than 0·25 from the surface. The youngest are simple hollow processes, almost transparent, and with a dermal papilla projecting into them, almost to their tip; a basal plate becomes developed which is striated parallel to the long diameter of the spine; as they grow the plates take on an oval form, and the colour gets darker and darker. The spines appear to be organs for defence and for seizing prey. Brief notes are given on the other organs, but there are no histological details.

Mode of Feeding in Flukes.* — M. A. Railliet reports that some sheep, which had died from rot, were injected with a blue colouring matter previous to dissection at the Veterinary School at Alfort; the flukes in the liver of one of these were carefully examined and were found to be themselves injected, the ramifications being stained blue. On teasing, it was easy to see that the contents of the intestine were formed of coloured plaster. At the same time it must be noted that there was not the least trace of the injection in the lumen of the bile-ducts. M. Railliet thinks that this discovery settles the disputed question of the mode of feeding of Flukes. He cannot doubt that the Flukes were occupied in sucking the vessels when the injection was driven in, and it may be justly supposed that these parasites are in the habit, under ordinary circumstances, of feeding on the blood of their host.

M. R. Blanchard † points out that this observation may explain the presence of erratic flukes in the blood-vessels; when they gain an entrance they are carried along by the current, are stopped in a capillary, and give rise to a tumour.

Nature of Monostoma leporis.‡—M. A. Railliet has been able to convince himself that the so-called *Monostoma leporis*, described by Kuhn as a Trematode, is a pisiform *Cysticercus;* two years before Kuhn, Rudolphi described a *Cysticercus leporis variabilis.*

Distribution of Gyrocotyle.§—Sig. F. S. Monticelli believes that *Gyrocotyle* is a parasite peculiar to the Chimæridæ, that *Chimæra* and *Callorhynchus* each harbour a species, and that the parasites have intermediate hosts in bivalves (*Mactra*, &c.) eaten by the Chimæridæ.

Ova and Embryos of Temnocephala chilensis.‖—Sig. F. S. Monticelli states that the ova of *Temnocephala chilensis* are fastened at either

* Bull. Soc. Zool. France, xv. (1890) pp. 90–1.
† T. c., pp. 91–2.
‡ T. c., pp. 132–3.
§ Atti Soc. Ital. Sci. Nat., xxxii. (1890) pp. 327–9.
‖ T. c. See Centralbl. f. Bakteriol. u. Parasitenk., viii. (1890) pp. 500–1.

end by a yellowish filament, 1·5 mm. long. Its substance is fibrous and it is also distinguished by its appearance from the shell-substance of the egg, to which the filaments are fixed by a finely granular mass. These filaments appear to be secreted by well-developed dermal glands, which are placed near the genital orifice. The embryos enclosed in the eggs are, save for the difference in size and the development of the reproductive organs, exactly like the adults.

Anatomy of Distomum fabaceum.* —Mr. J. M. Stedman has some notes on the anatomy of this Trematode, which was found in the large intestine of a Manatee; the author's account is purely descriptive.

External Differences in Species of Nematobothrium.† — M. R. Moniez reports that a large number of specimens of a new species of *Nematobothrium*—which he calls *N. Guernei*—were found on fifty-three specimens of *Thynnus alalonga* dredged during the voyage of the Prince of Monaco's yacht 'Hirondelle.' The specimens were from 0·3 to 0·5 metre long. At first sight, it was difficult to say whether the parasite was a Trematode or a Nematode. Nor did the investigation of the internal structure enable the author to at once determine the question. At the anterior end of the body and at the point ordinarily occupied by the mouth there are two genital orifices, very distinct from one another and placed one above the other, as is the case in many Cestodes. The male apparatus is formed of a penial pouch, and is continued by a sperm-duct into two immense testicular tubes; the oviduct is extremely long and folded several times along the whole length of the body, and it is continued into an ovary which presents the same peculiarity.

Near the hinder extremity is the orifice of the water-vascular apparatus, which is continuous with a tube of thick walls, very wide, and extending without any ramifications as far as the anterior part of the body. These are the only organs which the author has as yet been able to make out. But very large nerve-cells, like those already noticed in Trematodes, have been frequently seen in the tissues. The specimens found in the gills were in the form of cysts containing two individuals which were very delicate anteriorly but greatly swollen in the remaining part of their body; their structure, however, shows they belong to the same species as the others; the polymorphism appears to be due to the difference in the difficulty of development, according to the spot at which the embryos are fixed.

Cysticercoids of Freshwater Crustacea.‡—Herr Al. Mrázek describes several cysticercoids with caudal appendages from freshwater Crustacea, and diminishes the number of species of *Tænia* whose intermediate hosts were unknown. Cysticercoids were obtained from 80 per cent. of examples of *Cyclops agilis* examined. They lie freely in the body-cavity. The body is lens-shaped, and 0·12–0·18 mm. in diameter; it is covered by a completely hyaline layer, and the subjacent cuticle has numerous pore-canaliculi; the rostellum has eight or nine hooks. The parasites are found in both males and females, and in the latter the

* Proc. Amer. Soc. Microscopists, xi. (1889) pp. 85–101 (3 pls.).

† Comptes Rendus, cxi. (1890) pp. 833–6.

‡ Verhandl. der Kgl. Ges. der Wiss. Prag, i. (1890) pp. 226–48 (1 pl.). See Centralbl. f. Bakteriol. u. Parasitenk., viii. (1890) pp. 628–30.

gonads were degenerated. The hooks of the cysticercoid completely agree in form and size with those of *Tænia fasciata*, which lives in the intestine of domesticated and wild geese. Cysticercoids have also been found in Ostracoda—in *Cypris ovum* and *C. compressa;* as the infested animals lived for some time in captivity, the harmful influence of the parasite must be slight. These cysticercoids have hooks of the form and number of those of *Tænia coronula*, which has been found in the intestine of some species of Ducks. A new (third) species is now described from *Gammarus pulex*, but it is not yet known what its Vertebrate host is.

Generative Apparatus of Tænia Echinococcus.*—Herr R. v. Erlanger gives a description of the generative apparatus of *Tænia Echinococcus*. The female organs consist of the ovary, yolk-gland, shell-gland, and uterus, with their efferent ducts. All but the shell-gland open together into the atrium, which has a rounded or oval form, and consists of spindle-shaped cells. The yolk-gland is placed at the hinder end of the proglottis, and consist of two portions, one of which lies above the other. Each part is again divided into two lobes, and each lobe has an efferent duct which becomes united with its fellow. The ducts of the two chief parts unite at the median plane of the proglottis into a broad, unpaired yolk-duct, which passes forwards and opens into the ootyp. The separate follicles of the yolk-gland have a distinctly cellular wall. The yolk-cells are irregularly spherical or polyhedral in form. The unpaired ovary is derived from a paired one, has the form of a horse-shoe, with the concavity directed backwards, and lies in front of the shell-gland. The several lobules of the ovary possess walls which are formed by branched cells which are connected with one another by long processes and have the egg-cells between them, and contained, therefore, in a kind of follicle. The eggs have a large vesicular nucleus with nucleolus and chromatin framework, while their protoplasm stains intensely.

The oviduct commences with an ampulliform enlargement; its wall has a characteristic striated appearance, and consists of conical cells, placed on a homogeneous and pretty thick basal membrane; their axis is directed somewhat obliquely to that of the oviduct. The direction of this axis and the structure of the protoplasm is the cause of the striated appearance. The vagina, the lumen of which varies in width, has connected with it a large receptaculum seminis; beyond this the inner wall consists of a thick chitinous lamella, and is surrounded by a layer of strong circular muscles. The wall is, further on, provided with a large number of very fine, and probably chitinous hairs. The cuticle which covers the surface of the body bends round into the atrium and lines the inner wall of the vagina as far as the receptaculum.

The uterus has, likewise, a distinctly cellular wall; it extends forwards as far as the anterior boundary of the proglottis, where it lies dorsally to its axis; as it becomes filled with ova it becomes bulged out laterally, and at last fills up nearly the whole of the parenchyma. The uterus is never branched, but only bulged out laterally.

The testicular vesicles are from about forty to fifty in number, lie around the female organs, are scattered irregularly, and are most numerous in the most anterior and most posterior parts of the pro-

* Zeitschr. f. Wiss. Zool., l. (1890) pp. 555-9 (1 pl.).

glottis. Their fine efferent ducts, which have a distinct wall with much flattened cells, become united into two anterior and two posterior collecting ducts, which open into the hinder end of the vas deferens. This is a pretty thick and closely coiled tube which opens into the large penial (cirrus) sac, where it is prolonged into a spirally coiled cirrus. The neck of the pyriform sac and the terminal part of the vagina are surrounded by a common layer of strong circular muscles. The wall of the genital atrium as well as that of the cirrus is beset with hairs.

On the whole, it will be seen that the generative apparatus of *Tænia Echinococcus* does not essentially differ from that of other *Tæniæ*.

Tæniæ of Birds and others.*—Dr. v. Linstow has notes and descriptions of thirteen species, some of which are new. He first gives a detailed account of his species *Tænia puncta* fron *Corvus corone* and *C. nebula*. The pathological anatomy of *T. mediocanellata* is next discussed. *T. crassicollis* sp. n. was found in the intestine of *Sorex vulgaris;* the scolex is very large and broad, and the spindle-shaped rostellum is 0·22 mm. × 0·19 mm., and there are on it seventeen hooks 0·052 mm. long. *Diplostomum Cobitidis* sp. n. was found encapsuled and free in the body-cavity of *Cobitis barbatula*. *Echinorhynchus tæniæformis* sp. n. was found in the intestine of *Caranx* sp.; and *Spiropterina inflata* sp. n. lives attached to the gastric wall of *Scyllium immoratum*. *Filaria hyalina* and *Oxysoma tridentatum* are two new Nematodes, found respectively in the intestines of *Sorex vulgaris* and *Triton cristatus*. *Ascaris gracillima* sp. n. was found in an asexual stage in the intestines of *Cobitis barbatula*, *Phoxinus lævis*, and *Gastrosteus aculeatus*. A well-marked new species —*Trichosoma spinulosum*—was found in the cæcum of *Fuligula ferina*. In conclusion, there are some interesting notes on the Frog-parasite *Angiostomum nigrovenosum*.

Parasitic Origin of Pernicious Anæmia.†—M. A. Railliet finds that pernicious anæmia in man and animals may be caused by various parasites. The liver-parasites are *Distomum hepaticum* and *D. lanceolatum*, in the Sheep; *Coccidium oviforme*, in the Rabbit; *Echinococcus polymorphus*, in Man and Ruminants. The enteric parasites are various:—*Tæniæ*, in the Sheep and Rabbit; *Bothriocephalus latus*, in Man; *Ankylostoma duodenale*, in Man; *Dochmius trigonocephalus*, in Cats; the same and *D. stenocephalus*, in Hounds; *Sclerostoma hypostomum* and *S. tetracanthum*, in Horses; *Strongylus contortus* and *S. filicollis*, in Sheep and Oxen; *St. strigosus* and *St. retortæformis*, in Hares and Rabbits.

δ. Incertæ Sedis.

Morphological Significance of Organic Systems of Enteropneusta.‡ Prof. W. Schimkewitsch gives an abstract of two memoirs, written by himself in Russian, on the homology of various organs of the Enteropneusta, Echinodermata, and Chordata. He takes as his starting-point the stage in Echinoderm development which has been called by Semon the Pentactula. The proboscis of *Balanoglossus* is comparable to cephalic lobes, the cœlomic cavity of which is separated off from the archenteron

* Archiv f. Naturgesch., lvi. (1890) pp. 171–88 (1 pl.).

† Revue Génér. d. Sciences Pures et Appliq., i. (1890) pp. 294–9 (5 figs.). See Centralbl. f. Bakteriol. u. Parasitenk., viii. (1890) p. 500.

‡ Anat. Anzeig., v. (1890) pp. 29–32.

as an unpaired diverticulum. In correlation with the excessive development of the cephalic lobes we have the preoral part of the enteron, which Bateson took for the notochord, especially well developed. As in *Balanoglossus*, so in *Amphioxus*, we find a pair of enteric outgrowths in the anterior part of the archenteron; the left one becomes, later on, connected with the external medium in both forms. Of the three outgrowths from the archenteron in Crinoids the unpaired one corresponds to the cephalic cœlom of the Enteropneusta, and is converted into the ambulacral ring.

According to Hatschek we have, in the embryo of *Amphioxus*, to do with two divisions of the cœlom (myocœl and splanchnocœl); in the Enteropneusta we find this division only in the collar-segment, where the myocœl (Bateson's perihæmal cavity) is very closely connected with the longitudinal musculature. The pulsating vesicle of *Tornaria* (Bateson's proboscis-gland) is nothing else than a division of the cœlom, and probably represents the myocœl of the proboscis-segment.

The vascular system of *B. Mereschkowskii* is formed by two trunks—a dorsal and a ventral—which lie between mesenteries, and probably pass into one another at either end of the body. This arrangement obtains in *Amphioxus* and *Synapta*, as well as in Annelids and Nemertines.

The anterior part of the enteron of *Balanoglossus* is divisible into a suprabranchial and a subœsophageal; the latter is reduced in *B. Mereschkowskii* to a groove, which is represented by the endostyle of Tunicates, the hypobranchial groove of *Amphioxus*, and the thyroid evagination of *Ammocœtes*. Notwithstanding various attempts to homologize other structures with them, the gill-clefts remain characteristic of the Chordata.

The gonads of Annelids, Nemertines, Enteropneusta, *Amphioxus*, and the hypothetical ancestors of Echinoderms, are formed on the same type, and it can scarcely be doubted that the genital orifices of Nemertines and Enteropneusta should be homologized with the ectodermal part of the segmental organs.

The nervous system of *Tornaria* seems to consist of the cephalic ganglion beneath the eyes, whereof no trace is left in the adult *Balanoglossus;* the nervous tube of this creature corresponds to that of the Chordata; the anterior neuropore corresponds to the ciliated pit of the *Amphioxus*-larva and the ciliated duct of the neural gland of Tunicates. In no way can the dorsal and ventral nerve-trunks of *Balanoglossus* be compared with the nerve-trunks of Holothurians.

All the Bilateria may be arranged in four groups, according to the structure of the nervous system:—

(1) Gastroneura—with a cephalic ganglion and two ventral trunks.

(2) Tetraneura (Mollusca)—with a cephalic ganglion, two ventral, and two lateral trunks.

(3) Cycloneura (Echinodermata)—with no cephalic ganglion, but with an œsophageal ring and five radial trunks.

(4) Notoneura (Enteropneusta and Chordata)—with no cephalic ganglion, but with a dorsally placed nerve-tube.

Fecundation of Hydatina senta.*—M. Maupas has been able to convince himself absolutely that the "winter eggs" of this Rotifer are

* Comptes Rendus, xci. (1890) pp. 310-2.

the fertilized eggs. Seven hundred and ninety-six females were, from their birth, kept isolated from males; none of these produced any but the so-called summer egg. One hundred and seventy-two females, opportunely placed with males, gave rise in eighty-four cases to fecundated eggs; the other eighty-eight produced female parthenogenetic eggs. All the copulations, therefore, were not fertilizing. The author thinks that, with a little more care, he might have obtained a larger number of fertilized eggs. The females should be fertilized six to eight hours after emergence; some have been fertilized immediately on leaving the egg. Copulation may happen frequently after eggs have been deposited, but no further fertilization of eggs occurs. The males are polygamous, or may be so. In a further communication * M. Maupas states that he has discovered that copulation has no effect on those specimens that are about to lay female eggs. Each egg seems to be predestined to form a male or a female at the time when it is differentiated and begins to grow in the maternal ovary. The author does not despair of finding the time and causes which determine this. In *Hydatina*, as in some Hymenoptera, there is established between arrhenotoky (parthenogenetic production of males) and fecundating karyogamy, a relation so necessary that the second is impossible without the first. It is very probable that this absolute connection between these two processes is commoner than we think, and that fresh researches will discover it in other parthenogenetic creatures. It was found by experiment that there is no advantage in cross-fertilization.

Distribution of Pedalion mirum.†—Dr. O. E. Imhof draws attention to various localities—Budapest, Galicia, Azores, North Italy, Germany, and others—in which this remarkable Rotifer has, in recent years, been found. The localities indicate that the creature lives in very varying conditions of existence.

New American Rotifer.‡—Dr. D. S. Kellicott describes a new species of the genus *Cephalosiphon*, which he calls *C. furcillatus;* the dorsal antenna is provided with two stout, down-curved claws, the use of which is not quite clear. The entire length of the animal is 1/120 in.

Echinodermata.

Enterocœlic Nervous System of Echinoderms.§—M. L. Cuénot describes a third system of nerves in Echinoderms. In the Asteroidea there is, on the aboral side of each arm, a strong muscular cord, which gives off branches in all directions, and functions chiefly as the antagonist of the muscles which unite the ambulacral pieces. When a section is made of the wall of the body in this region, it is seen that the muscular bands are completely on the internal face of this wall. They are invested by a rather thick layer (40 μ in *Asterias glacialis*), which is formed by a nerve-centre and the peritoneal epithelium. The nervous part is formed by fibrils, which take the same direction as the muscles, and inclose a rather large number of nerve-cells. The cells of the

* T. c., pp. 505–7.
† Zool. Anzeig., xiii. (1891) pp. 609–11.
‡ Proc. Amer. Soc. Microscopists, xi. (1890) pp. 32-3 (1 fig.).
§ Comptes Rendus, cxi. (1890) pp. 836-9.

peritoneal epithelium, which are set side by side in a single and very regular layer, are each prolonged into a delicate filament, which crosses the fibrillar layer perpendicularly, and passes on to be attached to the subjacent connective tissue. The histological constitution of this nervous layer is, therefore, identical with that of the ambulacral nervous system, save that the ectodermal cells of the latter are replaced in the former by enterocœlic cells.

The author states that he has recognized this enterocœlic nervous system in all his types—*Asterias glacialis* and *tenuispinis*, *Echinaster sepositus*, and *Astropecten aurantiacus*. He has not been able to detect any communication between this centre and the intra-epithelial superficial plexus, which extends between the ectodermic cells of the outer wall of the body.

He thinks that this new nervous system recalls in a singular manner that which is so well developed in Crinoids. If we make a transverse section of an arm of an *Asterias* or an *Antedon* we find exactly the same elements from the oral surface:—(1) Ectodermal nerve-band, continuous with the epithelium of the ambulacra, and, in *Asterias*, with the ectodermal investment of the body; (2) radial schizocœl-sinus, greatly developed in *Asterias*, more reduced, but certainly present in the Neocrinoidea; (3) the radial ambulacral canal; (4) a large cavity, the prolongation of the cœlom of the disc, simple in Asteroids, divided by septa into three cavities in Crinoids; (5) the aboral wall of the body, inclosing muscular fibres and nerve-cords, greatly developed in Crinoids. We know, moreover, that the axial nerves of Crinoids are of enterocœlic origin. The genital nerve-ring of Echinoids, discovered by Prouho in *Echinus acutus* and *Strongylocentrotus lividus*, and by the author in *Arbacia pustulosa* and *Echinodiscus biforis*, ought to be put in the same category. In Ophiurids the same part is represented by the aboral ring, which goes from the axial sinus to the genital organs; this has been found in *Ophiocoma scolopendrina*, *Ophiothrix fragilis*, and others. It seems certain that the genital nerve-ring of Echinoidea and Ophiuroidea, like the aboral cords of Crinoidea and Asteroidea, are of mesodermal origin, and are developed at the expense of the enterocœlic epithelium; this is one of the most interesting exceptions in the developmental history of the nerve-centres of Metazoa. No aboral nerve-centre has yet been seen in *Synapta* or *Holothuria*.

Echinodermata of Yucatan and Vera Cruz.* — Mr. J. E. Ives describes the Echinoderms collected from these regions. *Holothuria Heilprini* sp. n. is related to *H. atra*, but the calcareous deposits are arranged in heaps, which produces an appearance of granulation over the surface of the body; *H. Silamensis* is allied to the group which (in Thiel's classification) contains *H. marmorata*, and while it presents differences from all members of it, it may, like them, or some of them, belong to one very variable and widely distributed species. *H. nitida* sp. n. is also allied to *H. atra*. The new genus *Thyraster* is instituted for *Echinaster serpentarius*, as the skeleton consists of quadrilateral plates arranged in regular longitudinal series, and not, as in *Echinaster*, of small narrow imbricated plates united into an irregular network. This

* Proc. Acad. Nat. Sci. Philad., 1890, pp. 317–40 (1 pl.).

collection, like others which have preceded it, affords evidence of the limited habitat of many species of Holothurians.

Crinoids of Port Phillip.*—A Port Phillip Biological Survey Committee has been formed, and twenty-nine specimens of Crinoids were sent to Dr. P. H. Carpenter, who refers them to five species, one of which is probably new. *Antedon macronema* is for the first time recorded from this locality.

Anthozoa.

Rate of Growth of Corals.†—Prof. A. Agassiz has had the opportunity of examining some corals attached to a cable which has been laid down about seven years. *Orbicella annularis* grew to a thickness of $2\frac{1}{2}$ in. in about seven years. *Manicina areolata* shows a rapid, and *Isophyllia dipsacea* a still more rapid rate of increase.

Corals of Tizard and Macclesfield Banks.‡—Mr. P. W. Bassett-Smith, R.N., has a report on the corals obtained by him when on board H.M.S. 'Rambler,' from the Tizard and Macclesfield Banks in the China Sea. One hundred and twenty-nine species of Madreporaria were obtained, and of the genus *Madrepora* there were as many as thirty-one species. Perhaps the most notable fact with regard to this collection is the number of species which have been found living at depths greater than 30 fathoms, which depth has until lately been supposed to be the limit of deep-building corals. Nineteen species have, however, been found between 31 and 45 fathoms. Five new species of *Madrepora*—a genus whose usual limit is 10 fathoms—were found living between 20 and 27 fathoms. The author indicates but does not describe the species which he regards as new.

Alcyonaria and Zoantharia from Port Phillip.§—Dr. S. J. Hickson has a preliminary report on the Alcyonaria and Zoantharia collected by the Port Phillip Biological Survey Committee. The author has had great difficulty in working out the collection, as the same form seems to have frequently had different generic and specific names applied to it. He gives a list of twenty-nine specimens, of which *Clavularia australiensis*, *C. ramosa*, and *C. flava* are new species; of each of these a short diagnosis is given.

Invagination of Tentacles in Rhizoxenia rosea and Asteroides calycularis.‖—In most Cornulariidæ the tentacles contract when the polyp contracts, but they are not invaginated; Prof. G. v. Koch has, however, noticed a true invagination of the tentacles in *Rhizoxenia rosea*. Invagination of the tentacles does not seem to have been noted among the Hexacoralla, but in *Asteroides calycularis* tentacles have been seen to be invaginated at their basal portion, and to be pushed in and out like the tube of a telescope. The matter is worthy of further investigation.

* Proc. Roy. Soc. Victoria, ii. (1890) pp. 135–6.
† Bull. Mus. Comp. Zool., xx. (1890) pp. 61–2 (4 pls.).
‡ Ann. and Mag. Nat. Hist., vi. (1890) pp. 353–74 (3 maps), 443–58.
§ Proc. Roy. Soc. Victoria, ii. (1890) pp. 136–40.
‖ Morphol. Jahrb., xvi. (1890) pp. 399–400.

Terminal Polyp and Zooid in Pennatula and Pteroeides.*—Prof. G. v. Koch gives figures of various stages of young and just adult specimens of *Pennatula phosphorea*. In the earlier stages it is quite easy to make out a terminal polyp, with a terminal pore or terminal zooid at its base. This arrangement is no longer apparent in an example with fourteen leaves, for the polyp is gone though the zooid is still terminal, and the same is the case in a specimen with thirty-eight pinnules. A short notice is also given of two young colonies of *Pteroeides spinosus*.

Structure of Cerianthus americanus.†—Prof. J. Playfair M'Murrich gives an account of the structure of *Cerianthus americanus*. The largest specimen obtained measured about 20 cm. in length, but those described by Verrill were much larger. The mesenteries are arranged on a very different plan to those of *C. membranaceus* and *C. borealis*; more than one pair reach the extremity of the body; there are in all ninety-two mesenteries, twenty-three of which are well developed, or pass more than half-way down the column. The sexes are separate, and the three specimens examined by the author were all females. The examination of the histological structure showed many points of resemblance to *C. membranaceus* and of difference from *C. borealis*. The author gives a detailed account of what he was able to observe. The ova are large and are imbedded in the mesoglœa of the mesenteries; the nucleus is large and always excentric, and usually projects very noticeably beyond the general surface of the ovum; one large nucleolus is always present.

Organization of Monobrachium parasiticum.‡—Herr J. Wagner has made a study of this fine Hydroid, discovered by Méréjkowsky in 1877. In most colonies the centre is almost entirely occupied by sexual individuals, while at the periphery the gonophores are intermixed with the hydranths, and at the extreme edge there are special forms, for which the author proposes the name of pseudonematophores. These last represent the "spiral zooids" described by Allman in *Podocoryne*, and by various authors in other forms. In *Monobrachium* the terminal swelling is a true battery of nematocysts, and the organ has clearly a defensive function. They differ from true nematophores by the possession of a prolongation of the gastric cavity, which is always wanting in true nematophores. Further, they do not emit pseudopodia, and in these two points the pseudonematophores approach the hydranths, between which and the nematophores they form an intermediate stage.

Monobrachium is nourished on the excrements of *Tellina*, to the shell of which it is fixed; and, as the currents produced by the siphons continually bring fresh water, this Hydroid may be regarded as a commensal. On the other hand, the protractile and single tentacles may be of use to the Molluscs, and we may, therefore, have to do with a case of symbiosis.

The ectoderm of the hydranths and of the pseudonematophores is formed by epithelio-muscular cells, every one of which seems to have the power of transforming itself into a supporting cell. The subepithelial

* Morphol. Jahrb., xvi. (1890) pp. 396–8 (7 figs.).
† Journal of Morphology, iv. (1890) pp. 131–50 (2 pls.).
‡ Arch. de Biol., x. (1890) pp. 273–309 (2 pls.).

layer is only well developed at the base of the hydranth and on many points of the hydrorhiza; in section a large number of nuclei become visible, the arrangement of which indicates the presence of several layers of cells with invisible contours. In some parts this layer is closely packed with nematocysts; all these cells are of the same kind—they have an ovoid form, and the filament has several strong spines. It is to be noted that these capsules have no cnidocils.

The author does not absolutely deny the presence of nerve or sensory cells in this hydroid, but he states that he was unable to find them. On the whole, the ectoderm of the hydranths and of the pseudonematophores gives evident signs of atrophy due to parasitism. The endoderm of the hydranth is formed of cells of very large size lying on circular muscular fibres; they form a syncytium on the inner surface, but on the outer the boundaries of the cells can be distinguished; the fusion on the inner surface is due to the fact that two or more adjoining cells send out pseudopodia which touch and fuse. There is thus formed a digestive protoplasmic layer, filled with nutrient and other particles, and entirely covering the internal surface of the gastric cavity.

The structure of the tentacle is interesting, as it presents an intermediate stage between the hollow tentacles of some and the solid tentacles of other hydroids. In fact, by supposing the cells of the internal epithelium of the tentacles of *Hydra* to become so large as to touch at either end of the tentacle, we get the arrangement which obtains in *Monobrachium*. The membrane proper is feebly developed, and is scarcely visible on the hydrorhiza; it gives rise to protuberances or crests among the ectodermal, and more particularly among the endodermal cells, in such a way that, if all the cells are removed, the surface of the membrane shows the contours of the bases of the cells. This appearance, however, is only seen in the median part of the hydranth. The membrane appears to be simple.

The gonophores are placed on short peduncles, and contain a medusa which becomes almost completely developed; there are two and not four sexual sacs. The author describes in detail the histological character of the medusoid body. The spot at which the genital products are matured is not that at which they appear. In the female, at any rate, the embryonic cells of the hydrorhiza of the female colonies are the female elements, and the same is probably true of the males. The author was unable to discover which germinal layer gave rise to the genital products. The sexual products are differentiated in the endoderm of the hydrorhiza, and are matured in the ventral epithelium of the radial canals. There is, then, in *Monobrachium*, a very important migration of sexual cells, notwithstanding the fact that this hydroid possesses an almost completely formed medusa. The embryonic cells pass along the endoderm from the hydrorhiza into the blastostyle, and then into the ventral epithelium of the radial canals, whence they reach the genital sacs by perforating the membrana propria.

Hydroids of Plymouth.*—Mr. G. C. Bourne gives a list of fifty-five species of Hydroids found at Plymouth. Among them is *Haloikema lankesteri* g. et sp. n., which is closely allied to *Halecium*, but is dis-

* Journ. Marine Biol. Assoc., i. (1890) pp. 391-8 (1 pl.).

tinguished by the ringing of the skin, the pedicellate hydrothecæ, and the non-retractile polyp, which is relatively much larger than the polyp of *Halecium*.

Porifera.

Nucleus of Sponges.*—M. J. Chatin recommends the Sponges, and especially the Calcareous forms, as very suitable objects for the study of the nucleus. Little preparation is necessary, as fixation by 33 per cent. alcohol and staining with methyl-green or picrocarmine will generally be found sufficient; where a more rigorous investigation is intended absolute alcohol is a good fixative. The mesodermal elements are the best to study, and especially those near the ectoderm.

The nucleus varies a great deal in form, and is at times ramified; the nuclear membrane is often clearly visible, for the cellular protoplasm is almost always clear and free from granules. The contained plasma has in it nuclein arranged in filaments which are aggregated towards the edges of the nucleus, or in similarly situated nucleoli.

M. Chatin points out that the form of the nucleus of Sponges is very similar to that of the nucleus of Protozoa—a fact, he thinks, of considerable interest in zoological histology, when we reflect on the relationship between Sponges and Protozoa which has been sometimes insisted on.

Protozoa.

Psycho-physiological Studies on Protists.†—Dr. M. Verworn has made an interesting series of investigations on the movements, reactions, and general behaviour of Protists. He began by studying the spontaneous movements of uninjured Bacteria, Diatoms, Rhizopods, Flagellata, and especially ciliate Infusorians. Then he investigated their behaviour in relation to various stimuli—luminous, thermal, electrical, chemical, and mechanical. He made a great number of experiments with excised portions of Rhizopods and Ciliata, studying their movements and their reactions. Finally he watched the normal life, the food-seeking, house-making, pairing of Protozoa.

He allows that the first impression of many Protists is that they possess many of the mental qualities of higher animals, for their movements often suggest sensation and deliberation. Further study does not corroborate this impression; his own conclusion is that "all their movements are expressions of unconscious psychical processes." Their structure is not such that there can be any centralized consciousness; the characteristic movements are retained by little excised fragments; the nucleus is certainly not a psychical centre. "There is no alternative but to identify the psychical processes in the Protist organism with the molecular processes therein, and to seek their fundamental conditions in the qualities of the molecules." Whether Dr. Verworn's conclusions are right or not, the abundant facts which he describes are most interesting.

* Comptes Rendus, cxi. (1890) pp. 889–90.

† 'Psycho-Physiologische Protisten-Studien. Experimentelle Untersuchungen,' 8vo, Jena, 1889, viii. and 219 pp., 6 pls. and 27 figs.

Mechanism of Sucking in Suctoria.*—Herr J. Eismond urges certain objections to the suggestion of R. Hertwig that the sucking mechanism depends on a shortening and subsequent elongation of the sucking tentacles. Observation, however, shows that these tentacles often remain quite stiff, and it is difficult to see how the food would not be ejected on the contraction of the tentacle. We must suppose that the tentacles play only a passive part, and seek elsewhere for the mechanism. It is suggested that it is to be found in the relations of the body-plasma to the outer world; where there is a diminution of pressure there must be a centripetal streaming into the sucking tubules, and so into the body. This is brought about by the contractile vacuoles, the activity of which must play the chief motor part in the sucking mechanism of the Suctoria, and, partly, in the swallowing mechanism of the Ciliata. What the author imagines to happen is, that as the contractile vacuoles pump out watery excretion-products from the body-plasm they act as aspirators, for in their diastole they diminish the turgidity of the body, and consequently produce an ascensive pressure in the sucking tubules.

Amphileptus flagellatus.†—Mr. C. Rousselet, under this name, describes a new species of Infusorian, which he has often found at Keston. It is 1/65 to 1/55 in. in size including flagellum, with a width of 1/100 to 1/120 in. At first sight it might be taken for an abnormal *Trachelius ovum*, but it is a true *Amphileptus*, distinguished from all the known species by its large size and its prominent and long trunk-like filament. The body is highly elastic and changes its form and withdraws its flagellum on the slightest pressure. The flagellum is carried in a graceful spiral curve in front of the body, when the creature is swimming.

The Genus Conchophthirus.‡—Prof. G. Cattaneo gives an account of the interesting Holotrichous Infusorian *Conchophthirus anodontæ* found on the gills of freshwater mussels. He discusses the synonymy of the genus, describes the animal and its movements, finds only one species in the bivalves, and gives reasons for believing that the Infusorians accompany the Glochidia when they leave the mother mussel.

Gigantic Specimens of Actinosphærium.§—Mr. S. Calvin has found near the State University of Iowa some Rhizopods which are distinctly visible to the naked eye. They are probably examples of *Actinosphærium Eichhornii*. But whereas the maximum diameter given by Leidy is 0·85 mm., there are scores in Mr. Calvin's jars more than 0·75 mm., and the largest specimen measured had a diameter of 1·36 mm.

Structure and Development of Spores of Myxosporidia.‖—M. P. Thélohan finds that the nucleus of Myxosporidia divides by karyokinesis. The polar capsules are formed at the expense of small masses of protoplasm which are differentiated in the sporoblast and inclose a nucleus; the mechanism of their formation presents many analogies with that

* Zool. Anzeig., xiii. (1890) pp. 721–3.
† Journ. Quek. Micr. Club, iv. (1890) pp. 114–5 (1 fig.).
‡ Rend. R. Ist. Lomb. Sci., xxii. (1889) pp. 604–14.
§ Amer. Natural., xxiv. (1890) pp. 964–5.
‖ Comptes Rendus, cxi. (1890) pp. 692–5.

observed by Bedot in the nematoblasts of *Velella* and *Physalia*. The protoplasmic mass of the spore is derived from another part of the sporoblast; it incloses two nuclei and a vacuole, the presence or absence of which is constant in one and the same form.

Cercomonas intestinalis.*—Herr E. Müller found in the intestine of an executed criminal an infusorian which accurately answered to the description given by Davaine of *Cercomonas intestinalis*. Directly after the execution, parts of the intestine were placed in Müller's fluid, chromic acid, and also alcohol. The infusorian had an oval or pyriform body, one end of which was continued into a tail, while the other, which was rounded off, carried a whiplike cilium. The length of the body was 0·006 mm., and the breadth 0·002 mm. The protoplasm contained one or two nuclei.

The parasite was only found in the jejunum. The location of the animals in the intestinal mucus was very characteristic; they formed a compact mass covering as with a membrane the surface of the intestinal mucosa, while those lying a little deeper were arranged in groups. The author notes that the presence of these parasites gave rise to no pathological changes.

Hæmatozoon of Malaria and its Evolution.†—M. Laveran, the author of the 'Traité des fièvres palustres,' attacks the position maintained by Golgi, Feletti, Anatolei, and others that the various types of malaria are produced by different micro-organisms of the same class. He considers that the blood-parasite is one and the same although variable in form, and that its development may not always be alike. According to him the type of the fever depends rather on the condition of the patient, on his predisposition, and on the length of his exposure to the malaria, than on differences in the forms of the parasite found in the blood.

Phagocytosis in Frogs and Birds.‡—As another contribution to the doctrine of Phagocytes, Herr Danilewski records his experiments on frogs and birds. Blood infected with hæmogregarinæ was transfused in the anterior abdominal vein of frogs. In 1/2 to 1 hour the foreign corpuscles were found to have been picked up by the large phagocytes of the frog. The hæmoglobin of the corpuscles soon vanishes, in a few hours the contour has become less visible, and in two or three days the parasite alone remains. Finally even this latter becomes more transparent so that at last only the empty cuticular sac and the bright nucleus of the blood-corpuscle are left. If the corpuscle contains only an early condition of the parasite then its destruction is all the more rapid, owing to the want of a cuticle. Observations were best effected by sucking the infected blood with some air into a flattened capillary tube; in this way they could be carried on for two or three days at a temperature of 36°–39°.

* Nordeskt Med. Archiv (Stockholm), xxi. (1889) pp. 1–12. See Centralbl. f. Bakteriol. u. Parasitenk., viii. (1890) pp. 591–3.

† La Semaine Méd., 1890, No. 27. See Centralbl f. Bacteriol. u. Parasitenk., viii. (1890) p. 559.

‡ Annales de l'Institut Pasteur, iv. (1890) p. 432. See Centralbl. f. Bakteriol. u. Parasitenk., viii. (1890) p. 710.

In a similar way the destruction of hæmatozoa by phagocytes was observed when frog's blood was added to that of the bird. The parasites of the bird are considered by the author to be allied to the malarial cytoparasites of man, and they are distinguished as the "malarial" parasites of birds.

When frog's blood is added to that of owls which contains infected corpuscles and melanin granules, a considerable number of the bird's corpuscles are found to be taken up by the frog's large leucocytes within twenty-four hours at 15°–18° C. The process of intracellular digestion goes on until the blood-corpuscles and its parasite have disappeared, the nucleus lasting a little longer. Finally, melanin granules are visible in the protoplasm of the phagocyte, which also shows an active vitality; other and similar observations are recorded of mixing malarial bird's blood with uninfected blood of birds and also with that of the dog.

That birds suffer from malaria the author thinks is proved by the anæmia and melanæmia that occurs in them, and also from the brown and black colour of the spleen and bone-marrow, e. g. in ravens, magpies, and owls. Moreover the presence of melanin granules is easily demonstrated microscopically.

BOTANY.

A. GENERAL, including the Anatomy and Physiology of the Phanerogamia.

a. Anatomy.

(1) Cell-structure and Protoplasm.

Absorption of Solid Substances by Protoplasm, and Formation of Vacuoles.*—Prof. W. Pfeffer has made a series of observations on the mode in which solid substances are absorbed by living protoplasm, the object of examination being chiefly plasmodes of *Chondrioderma difforme*. He believes that the absorption cannot be the result of chemical irritation nor of sensibility to contact, but of a purely mechanical force, whether from the weight of the substances absorbed, or from the resistance which they offer to the movements of the arms of the plasmode. Passing through the hyaloplasm, these substances are often taken up by vacuoles, though this is not always the case. After a certain period they are again expelled from the plasmode, but only while it is in motion and undergoing changes of form. Absorption of solid substances by protoplasm inclosed in a cell-wall was also observed.

Pfeffer contests the view of de Vries and Went† that all vacuoles must necessarily result from the division of vacuoles already in existence. He was able, by placing the plasmode in a saturated solution of a substance which is not too soluble and at the same time is not injurious, to produce in the hyaloplasm artificial vacuoles with all the properties of natural vacuoles. He found in these plasmodes no sharp distinction between hyaloplasm and granular protoplasm, the latter being simply the former rendered turbid by imbedded substances. The artificial vacuoles may even possess slight powers of pulsation.

With regard to the consistency of protoplasm, the author asserts that bodies composed of naked protoplasm, and especially the vibratile cilia of swarm-cells and of antherozoids, have a greater power of cohesion than protoplasm inclosed in a cell-wall. With regard to the cause of movements of irritability, such as those of the stamens of Cynaraceæ, he combats the theory of Vines and Gardiner, that it is due to an active contractility of the protoplasm, since, in such cases at all events, the protoplasm does not possess a sufficient degree of cohesion. The cause of the movements must be sought for either in an osmotic elimination of substance, or in a diminution of turgidity.

The author states that certain substances diffuse rapidly through the cytoplasm, while they pass only comparatively slowly through the membrane of the vacuoles; this difference demonstrates, in his opinion, the presence of continuous protoplasmic membranes which determine the osmotic absorption of substances by the protoplasm.

Cell-division in Spirogyra.‡—M. C. Degagny has adopted a new method of observing cell-division in *Spirogyra orthospira*, from which he has obtained interesting results. He exposes the filaments for some

* Abhandl. Sächs. Gesell. Wiss., xvi. (1890) pp. 149-345. See Bot. Centralbl., xliv. (1890) p. 180.

† Cf. this Journal, 1888, p. 981. ‡ Comptes Rendus, cxi. (1890) pp. 282-4.

minutes to the vapour of osmic acid, and then immerses them for 12 hours in the chromo-formo-osmic fluid similar to Flemming's. They are then washed several times, and preserved in a dilute solution of glycerin in water which is allowed to evaporate slowly. The staining reagents used are a similar solution of glycerin tinted by acetified methyl-green and by fuchsin. Immediately after the separation into two portions of the chromatic substances which form the nuclear plate, the granulations stained red, previously disseminated through the protoplasmic masses, accumulated at the poles, concentrating themselves in proportion as the two halves of the nuclear plate approach one another. They unite so as to form a more or less complete disc, near which each half of a nucleole places itself. At this moment the nuclear membrane, stained a pale red, commences to reappear opposite the disc, each half of a nucleole being surrounded on the outer side by the disc of granulations, and on the inner side by the nuclear membrane in the nascent condition. The complete re-formation of the nucleus follows immediately.

Growth of the Cell-wall.*—From observation of a peculiar mode of growth which occurs in the development of the wings on the stem in species of *Euonymus*, Miss Emily L. Gregory has arrived at a conclusion in harmony with Strasburger's hypothesis that growth in surface is effected by stretching, rather than with Krabbe's theory † that such growths take place partly by intussusception.

(2) Other Cell-contents (including Secretions).

Calcium and Magnesium Oxalate in Plants.‡—M. N. A. Monteverde finds that calcium oxalate is much more widely distributed in grasses than has been generally supposed, and its presence or absence is characteristic not only of the species, but also of the genus, and largely of the tribe. In 162 out of 550 species, and in 29 out of 94 genera examined, he found crystals present. Magnesium oxalate occurs in the form of strongly refractive spherocrystals with radial striation, or of irregular aggregations in the epiderm. When crystals are not present in grasses, all the green cells always contain drops of oil, which shows the reactions of a fatty oil.

In etiolated leaves of grasses much smaller quantities of crystals of calcium oxalate are found than in green leaves; their formation appears to be dependent directly on the light. The author believes that the primary calcium oxalate arises as a secondary product in various chemical changes of the proteids; and that the secondary calcium oxalate, the formation of which goes on *pari passu* with the disappearance of the nitrates in the leaves, must be regarded as a secondary product in the new formation of the proteids.

Yellow and Red Colouring Matters of Leaves.§—According to Sig. L. Macchiati, the red pigment in the leaves of plants isolated by

* Bull. Torrey Bot. Club, xvii. (1890) pp. 247–55 (1 pl.).

† Cf. this Journal, 1888, p. 441.

‡ 'Ueb. d. Ablagerung v. Calcium- u. Magnesium-Oxalat in d. Pflanze' (Russian), St. Petersburg, 1889, 81 pp. and 1 pl. See Bot. Centralbl., xliii. (1890) p. 327.

§ Atti Soc. Nat. Modena. See Morot's Journ. de Bot., iv. (1890), Rev. Bibl., p. xlv. Cf. this Journal, 1889, p. 240.

Arnaud * is identical with the erythrophyll of Bourgarel and the chrysophyll of Harsten; while the yellow or yellow-red substance extracted by Immendorff from green leaves cannot be identified with this pigment; it is a product of transformation of some other colouring substance, probably of erythrophyll. The green substance of the chlorophyll-grains is constantly accompanied by two yellow crystallizable substances, one of which, xanthophyllidrine, is soluble, the other, xanthophyll, insoluble in water. Besides these yellow substances, leaves constantly contain a red substance, erythrophyll, to which authors have given different names, and which Arnaud seeks to identify with the carotin of cultivated carrots.

Pigment of the Synchytrium-galls of Anemone nemorosa.†—Herr F. Ludwig finds that the attacks of the parasitic *Synchytrium Anemones* on *Anemone nemorosa* produce in the epidermal cells of the leaves and flowers a red pigment very soluble in water, with a very characteristic absorption-spectrum, apparently identical with that of anthocyan. It apparently serves the purpose of a protection against snails.

Dulcite in Plants.‡—By extracting with alcohol, Prof. J. Borodin found dulcite in *Melampyrum nemorosum*, *pratense*, *sylvaticum*, and other species of the genus, in all parts except the ripe seeds, especially in the secondary shoots, corolla, and unripe pericarp. In other plants belonging to the Scrophulariaceæ, e. g. *Rhinanthus crista-galli* and *Scrophularia nodosa*, he was unable to find any trace of it. Dulcite was found in all species of Celastraceæ examined, viz. 11 species of *Euonymus*, 3 of *Celastrus*, and 1 of *Schæfferia*, in all parts except possibly the root. That dulcite, like the carbohydrates, takes part in the vital processes of the plant, is shown by the fact that in *Euonymus japonicus* it entirely disappears from the leaves before their fall.

Strophanthine.§—Dr. T. R. Fraser publishes an elaborate account of *Strophanthus hispidus*, and its use in Africa as an arrow-poison. The poison is obtained exclusively from the fruit, where its active principle occurs chiefly in the endocarp, the placenta, and the comose appendages of the seeds. It is however found, though to a smaller extent, in the root and leaves, as well as in the epicarp and mesocarp. From the bark, both of the stem and of the branches, it appears to be entirely absent.

(3) Structure of Tissues.

Collenchyme.‖—Herr C. Müller has investigated the nature and structure of collenchyme more closely than has hitherto been done. He classifies the various forms under the following heads, viz.:—(1) with thickening at the angles (typical collenchyme); (2) with walls thickened on all sides (bast-collenchyme); (3) with walls thickened on all sides and the inner lamella of each cell strongly differentiated; (4) with tangential thickening-plates; (5) with uniform thickening of the walls

* Cf. this Journal, 1890, p. 350.

† Verhandl. Bot. Ver. Brandenburg, xxxi. (1890) pp. vii.–viii. (1 fig.).

‡ Rev. Sci. Nat. St. Pétersbourg, 1890, pp. 26–31 and 55. See Bot. Centralbl., xliii. (1890) p. 175.

§ Trans. Roy. Soc. Edinb., xxxv. (1890) pp. 955–1028 (7 pls.).

‖ Ber. Deutsch. Bot. Gesell., viii. (1890) pp. 150–66 (1 pl.).

which bound intercellular spaces; (6) collenchyme resulting from secondary metamorphosis which has taken place at a late period (meta-collenchyme; (7) temporary collenchyme or proto-sclerenchyme.

Collenchyme-tissue is always distinguished from bast-cells by being composed of living cells. It seldom contains more than a small quantity of chlorophyll; but, whether in a young or mature condition, its cells are always filled with water, and its primary function is to serve as a store-house for water, which is also always contained in the thickenings. At an early period, however, it always acquires its secondary function as a mechanical supporting-tissue; and this it performs not only while the organs are increasing in size, but also when they have passed over into its permanent condition.

Nutrient Layer in the Testa.*—Herr J. Holfert has investigated the structure of the layer which is almost always found beneath the sclerenchymatous layer in the testa of seeds. Although in the ripe seed this zone has very commonly entirely disappeared, in the unripe seed it consists of cells of ordinary structure, containing abundance of water, starch, and even of chlorophyll-grains. It is a transitory storing-tissue, and consists of parenchymatous cells, the contents of which are used up, during the process of ripening, in secondary cell-wall thickenings and other portions of the tissue of the testa. It may occur in one layer or two, separated by sclerenchyme.

The author classifies the various forms of this tissue under three types, of which the first is by far the most common, viz.:—(1) There are one or more nutrient layers and one or more sclerenchymatous or collenchymatous or thick-walled layers with secondary thickenings; (2) one nutrient layer, and no layers with secondary thickenings; (3) the nutrient layer is replaced by a permanent layer of parenchyme; there are no layers with secondary thickenings. This nutrient tissue is usually developed from one or more rows of cells, not to be distinguished from the rest, in the integument of the unimpregnated ovule. The number of rows of cells almost always increases, and sometimes the tissue is entirely formed, after impregnation. A very large number of special cases are described belonging to a great many different natural orders.

Foliar Fibrovascular System.†—By this term M. O. Lignier understands all the bundles which descend from a leaf, whatever their number or distribution, as well as those which penetrate the limb and the petiole of the leaf, and those which descend into the stem and constitute the leaf-trace. In the simplest case (Conifers and some Angiosperms) this system is composed simply of a single bundle, situated in the plane of symmetry of the leaf; but it is usually much more complicated. One mode of complication consists in a lateral extension, and also often a longitudinal breaking-up of the conducting tissues. The system may, when more complicated, consist of one or more principal bundles distributed over a more or less open convex arc; the broadening of these produces secondary (supernumerary) bundles, which again may be changed from

* Flora, lxxiii. (1890) pp. 279–313 (2 pls.).

† Bull. Soc. Linn. Normandie, 1888–9 (1890) pp. 81–92. Cf. this Journal, 1888, p. 985.

intercalary to internal or external by the folding of the arc. The mode in which these variations and complications take place is often characteristic of natural families.

Cuttings of the Vine.*—According to M. L. Ravaz, at the point where a cutting of the vine puts out a root, the generative layer becomes more active over a space of 4–5 mm. diameter, and forms xylem internally, phloem externally, the root originating in the outermost layer of cells of the phloem. The "digestive pocket" is formed at the expense of the innermost layer of the medullary ray of the preceding year. In order to make its exit, the root has to penetrate the phloem of the preceding year and a layer of bark, and consumes in its progress a very spongy and thin-walled tissue formed from the innermost layer of the corky envelope of the fibrovascular ring. This takes place in nearly all the varieties of the vine examined. Decortication facilitates the rooting of the cutting, but only by promoting the penetration of water into its tissues.

Cystoliths.†—Dr. L. Radlkofer describes the various forms of cystoliths and the cells in which they are contained. The natural orders in which their presence has been certainly determined amount to 10, viz.: —the Urticaceæ, Acanthaceæ, Cucurbitaceæ, Begoniaceæ, Gyrocarpeæ, Olacineæ, Cordiaceæ, Borragineæ, Hydrophyllaceæ, and Verbenaceæ. In addition to ordinary lithocysts, the cystolith may be developed in hairs with moderately thick walls and superficial calcareous deposits, which are frequently collected into rosettes.

Mestome-sheath of Grasses.‡—Herr S. Schwendener finds that in the leaves of Gramineæ the mestome-bundle is usually inclosed in a typical protecting sheath, and that its formation is not dependent on external conditions; but that it can be used, to a large extent, as a taxonomic character. The cells of this sheath are parenchymatous, often with sharpened ends; their walls have roundish or oval pores, and the thickening is usually on the inner side. It frequently, in the smaller bundles, completely surrounds the sieve-portion only. Whether this mestome-sheath is present or not, each separate bundle in the leaves of grasses is surrounded by a parenchymatous sheath.

A similar sheath occurs also in some other natural orders, as in the Stachydeæ among Labiatæ (it is wanting in the Ocymoideæ). It is almost invariably present in underground stems, even when entirely wanting in the aerial organs.

Mucilage and other glands of the Plumbagineæ.§—Mr. J. Wilson in the first place draws a distinction between the two sets of secreting organs, viz. the Mettenian glands, characterized by the secretion of calcium carbonate, which are universally distributed over the vegetative organs, and the mucilage-glands, which are confined to the axillary regions. Glands displaying every stage of gradation from the one form to the other are, however, met with in abundance; there can be no doubt that both sets of glands have the same origin, and it is

* Comptes Rendus, cxi. (1890) pp. 426–8.
† SB. K. Bayer. Akad. Wiss. München, 1890, pp. 115–27.
‡ SB. K. Preuss. Akad. Wiss., xxii. (1890) pp. 405–26 (1 pl.).
§ Ann. of Bot., iv. (1890) pp. 231–58 (4 pls.).

very probable that the Mettenian glands are the primordial form. With regard to the stalked glands on the calyx of *Plumbago*, the author states that one can hardly hesitate to affirm that they are extremely specialized forms of Mettenian glands seen in typical condition on the sepals of *Ceratostigma*, *Statice*, &c. The presence of Mettenian glands is most probably a universal feature in the cotyledons of the family. The absence of mucilage-glands from the cotyledons of *Plumbago*, and their invariable presence in the cotyledons of *Armeria* and *Statice*, point to some occult and exceedingly important functions which mucilage performs in the economy of the species of the latter genera.

Besides numerous Plumbagineæ, a considerable variety of plants having an affinity with this natural order were studied. The glands of Frankeniaceæ and Tamaricineæ most nearly approach them, the latter especially bearing, in respect of both form and function, a marked resemblance to chalk-secreting Mettenian glands. The Frankeniaceæ are recognized to be related, although remotely, to the Plumbagineæ, and it is a remarkable coincidence that they affect maritime situations, and are mucilaginous in character.

Structure of Apocynaceæ.*—According to M. Garcin, it is always possible, by microscopical examination, to determine that the least fragment of stem belongs to either the Asclepiadeæ or Apocynaceæ, the most important common characteristic of these two orders being the presence of unseptated laticiferous tubes. The structure of the bast indicates an alliance with the Solanaceæ, Loganiaceæ, and Convolvulaceæ. The more important points in the anatomy of the Apocynaceæ are described in detail, and the variations which occur within the order.

Campanulaceæ and Compositæ.†—Herr J. Seligmann discusses the differences and resemblances between these two natural orders in the structure of their tissues, and asserts that the phenomena point to a near affinity between the two; the most important difference being the absence of tracheid-fibres in the Compositæ. The Lobeliaceæ present, in many respects, a connecting link between the Campanulaceæ and the Compositæ.

(4) Structure of Organs.

Variations in the Flower of the Snowdrop.‡—Prof. G. Stenzel describes the variations which occur in the flower of the snowdrop in the following points:—The number of perianth-leaves and stamens, whether in the way of increase or diminution—this usually takes place symmetrically in both sets of organs; or in the occurrence of two flowers in the same sheath—this is the result of fastigiation, not of chorisis.

Nectary-covers.§—According to Prof. F. Delpino, the chief function of the lid or cover with which the nectaries of many flowers are provided, is to protect the honey against the visits of hurtful insects, such as ants. The fact that they not unfrequently occur in pendent flowers refutes

* Ann. Soc. Bot. Lyon, xv. pp. 197–448 (2 pls.). See Bot. Centralbl., xliii. (1890) p. 207.

† Bot. Centralbl., xliii. (1890) pp. 1–5.

‡ Luerssen u. Haenlein's Biblioth. Bot., Heft 21, 1890, pp. 1–45 (2 pls.).

§ Malpighia, iv. (1890) pp. 21–3.

the opinion which has been expressed by some writers, that their main purpose is to prevent the access of rain to the nectary.

Variations in the Structure of the Acorn.*—Prof. G. Stenzel describes the variations in the structure of the fruit of *Quercus pedunculata* in the following points:—(1) In their size and shape; (2) In the unequal size of the cotyledons; (3) In the variable number of the cotyledons, which may be reduced to one either by the suppression of one or by coalescence, or may be increased to three or rarely to four; (4) In the lateral position of the plumule; (5) In the occurrence of two, or more rarely of three seeds in the ovary; (6) In polyembryony; more than two embryos were never observed.

Buds of Sempervivum and Sedum.†—Prof. A. Kerner v. Marilaun describes the structure of the buds which detach themselves for the purpose of propagation from *Sempervivum arenarium* and *soboliferum* and *Sedum dasyphyllum*. In the species of *Sempervivum* minute buds are formed in the axil of the leaves of the rosette; these put out filiform stolons, the ends of which are densely covered with leaves; these globular terminal portions become detached by the withering of the lower part of the stolon, are blown away, and develope into new plants. In *Sedum dasyphyllum* it is not uncommon for the flowers themselves to be metamorphosed into a rosette of small leaves; or buds may be found imbedded in the tissue of the upper surface of the very thick leaves of the central portion of the stem, or elevated on long stalks in the axil of the lower leaves. All these become detached and germinate in the same way.

Dormant Buds in Woody Dicotyledons.‡—M. A. Prunet states that all woody plants have dormant buds, but that these buds are often very small, and hidden in the bark; microscopical examination is frequently necessary to determine their existence. Their connection with the pith of the stem is by means of a large medullary ray. These dormant buds are not only met with in the axil of ordinary leaves, but at the base of rudimentary leaves and bud-scales; and one or more additional buds often accompany the normal axillary bud. In exceptional cases the additional buds may appear opposite the point of emergence of the lateral foliar traces, in the axil of the plurifascicled leaves. The duration of dormant buds depends upon their means of defence against the sources of destruction, especially desiccation.

Leaves of Nymphæaceæ.§—Prof. G. Arcangeli describes the structure of the submerged, aerial, and floating leaves of *Nymphæa alba* and *Nuphar lutea*, which agrees with the well-known features of the leaves of other water-plants. The formation of submerged leaves only in great depths he does not regard as the direct result of the greater depth of water, but rather as due to a weakening or decrease of vital energy, resulting from the greater depth of the roots below the surface.

* Luerssen u. Haenlein's Biblioth. Bot., Heft 21, 1890, pp. 46-65 (1 pl.).
† Oesterr. Bot. Zeitschr., xl. (1890) pp. 355-7 (5 figs.).
‡ Journ. de Bot. (Morot), iv. (1899) pp. 258-63.
§ Nuov. Giorn. Bot. Ital., xxii. (1890) pp. 441-6.

Leaves of Conifers.*—M. A. Daguillon draws the following conclusions from his work on the evolution of the leaves of the Abietineæ:—(1) The existence of primordial leaves, that is, of leaves intermediate between the cotyledonary leaves and those of the adult plant, is constant. (2) The passage from the primordial form can take place without numerous transitions, as in *Pinus*, or by insensible gradations, as in *Abies*. (3) This passage is sometimes characterized by a modification in the phyllotaxis. (4) Sometimes also it is marked by a change in the state of the epidermal surface. (5) It is nearly always accompanied by the development, below the epiderm, of one or more sclerenchymatous layers, which afford the leaf protection and support. (6) The pericyclic sclerenchyme, which incloses more or less completely the median vein, acquires a considerable development. Further, among the two sorts of elements of which it is composed (cells with areolated punctations and fibres with smooth membranes), the latter are often absent from the primordial leaves, appearing with the passage from the primordial to the definite form. (7) In certain genera (*Abies*, *Pinus*) the fibrovascular system of the median vein proceeding from a single bundle of the stem bifurcates in the interior of the adult, while it remains simple in the primordial leaf. (8) In all cases the number of the conducting elements of the xylem and of the phloem augments when the primordial passes to the mature leaf. (9) When the foliar parenchyme is heterogeneous and bifacial, the differentiation of the palisade-tissue is generally accentuated in the adult leaves.

Leaves of Marine Phanerogams.†—Pursuing his examination of the leaves of aquatic plants, M. C. Sauvageau states that the family of Hydrocharideæ contains only three genera adapted to live in sea-water, *Enhalus*, *Thalassia*, and *Halophila*. The leaf of *Enhalus aceroides*, besides its dimensions and absence of ligule, is distinguished from that of all other marine flowering plants by the long fibrous filaments, by the anatomy of the fibrovascular bundles, and by the double orientation of the fibrovascular bundles of the limb. *Thalassia* differs from *Enhalus* in the structure of the limb, the two species of *Thalassia* differing from one another in the nature of the teeth at the extremity of that organ. In *Halophila* there is but very slight differentiation in the structure of the leaf.

The small genera *Halodule* and *Phyllospadix* present nothing very remarkable in the structure of their leaves. *Halodule* has secreting cells which are entirely epidermal; both genera have non-lignified fibres in the vascular bundles between the xylem and the phloem.

Summing up the conclusions of his study of the leaves of marine Phanerogams, M. Sauvageau states that if those flowering plants which live normally in the submerged condition are descended from terrestrial plants which have adapted themselves to this new mode of existence, the adaptation must have taken place in several different ways. The presence and the importance of a more or less lignified mechanical system vary greatly in the different genera. Except in the genus *Halophila*,

* Rev. Gen. de Bot. (Bonnier), ii. (1890) pp. 154–61, 201–16, 245–75, 307–20, 345–58 (4 pls. and 68 figs.).

† Journ. de Bot. (Morot), iv. (1890) pp. 269–73, 289–95, 321–32 (12 figs.). Cf. this Journal, 1890, p. 741.

the anatomical study of the leaf is of great importance for the determination of the genus and the species, the more so in consequence of the rarity of the flowers and of the fruits.

Leaves of Aloineæ.*—Sig. D. Lanza describes the structure of the leaves in a large number of Aloineæ, which agree in all essential characters. The cuticle varies greatly in thickness according to the species; the epiderm is homogeneous, and is composed of a single layer of cells; next to the epiderm comes an assimilating tissue, consisting of a very variable number of cells. Scattered through the assimilating parenchyme are a number of cells with suberized walls and sometimes of great length, containing raphides. The vascular bundles are of uniform structure throughout the order, and each is surrounded by its own endoderm; the cells which contain the peculiar bitter principle constitute a layer outside the sieve-cells. The surface of the leaves of *Haworthia* and *Gasteria* is covered with excrescences originating from below the epiderm, and composed of colourless cells, the function of which appears to be to protect the plant from excessive insolation. The author states that the leaves of *Haworthia fasciata* altogether change their habit with the locality in which they grow, being flat or erect, according as they are exposed to shade or to sunlight. He finds no sufficient characters, either in the flower, the fruit, or the leaves, for distinguishing the genera *Aloe*, *Gasteria*, *Haworthia*, and *Apicra*.

Filaments in the Scales of the Rhizome of Lathræa squamaria.†—Herr A. Scherffel maintains his previous view that these structures are not of a waxy nature, but are living bacteria, of which he finds also the zoogloœa-form. This view he supports by microchemical evidence against the adverse criticism of Jost. Their presence, or at all events their abundance, appears to depend on the richness in protoplasm of the scales or glands in connection with which they are found.

Trichomes of Corokia budleoides.‡—Dr. A. Weiss describes the structure and the mode of development from a single epidermal cell of the remarkable hairs which cover both surfaces of young, but the under surface only of mature leaves, as well as the axis of this plant (Cornaceæ). They are of the form which he designates T-hairs, consisting of a very elongated cell fixed transversely at nearly its centre to a pedicel composed of four or five short cells. The membrane of the T-cell is largely impregnated with calcium carbonate; and the hairs evidently serve the purpose of protecting the plant against the attacks of animals, and also against the penetration of the mycele of fungi.

Bulbils of Malaxis.§—According to Herr V. A. Poulsen, the bulbils often found on the apices of the leaves of *Malaxis paludosa* resemble ovules in having their axis clothed with an integument-like sheath. They have neither vascular bundle nor root, and are developed from the epiderm of the mother-leaf. New bulbils are sometimes formed at the margin of the sheath.

* Malpighia, iv. (1890) pp. 145–67 (1 pl.).

† Bot. Ztg., xlviii. (1890) pp. 417–30 (1 fig.). Cf. this Journal, 1889, p. 89.

‡ SB. K. Akad. Wiss. Wien, xcix. (1890) pp. 268–82 (1 pl. and 1 fig.).

§ 'Om Bulbildannelsen hos Malaxis paludosa,' Kjöbenhavn, 1890. See Bot. Centralbl., xliii. (1890) p. 336.

Morphology of Utricularia.*—Prof. K. Goebel describes a number of species of *Utricularia*, chiefly from the East Indies. In *U. orbiculata* the embryo of the very small seeds has no radicle; of the two minute cotyledons, one appears to develope into the first leaf, the other into the first bladder or into a stolon. The terrestrial species are divided into three groups—those in which the leaves are without bladders, those in which the leaves have bladders, and those in which the leaves have normal stolons.

Of the leaves, Goebel describes six kinds, four of them belonging to the aquatic, two to the terrestrial forms. The stolons are of two kinds, leafy and leafless. In the aquatic species the leafy stolons are branching floating shoots, bearing the leaves in two rows; in the terrestrial forms the leaves are usually dorsal, the stolons lateral or ventral. The leafless stolons may either bear bladders, or may be naked rhizoids without either leaves or bladders.

The bladders are found on the primary shoot, on the stolons, and on the leaves. Each species has its own characteristic form of bladder, and these may be classified in three groups:—(1) Those of the aquatic species, which more or less resemble the bladders of *U. vulgaris;* (2) bladders with long antennæ and the upper wall of the funnel elongated (*U. orbiculata*, *cærulea*, *bifida*, *elachista*, &c.); (3) bladders with broad funnel-like opening and a proboscis (*U. rosea*, *Warburgi* sp. n., &c.). The stolons may be either axial structures or metamorphosed leaves.

Structure of Sapindaceæ.†—Dr. L. Radlkofer discusses in great detail the anatomy and morphology, the limits and affinities, and the classification of the hundred and seventeen genera belonging to this natural order, which he divides into two suborders—the Eusapindaceæ, with a solitary, apotropous, erect or suberect ovule in each loculus; and the Dyssapindaceæ, with two or more (rarely solitary) epitropous and pendulous ovules in each loculus.

β. Physiology.

(1) Reproduction and Germination.

Hybridization and Crossing.‡—Herr W. Focke finds that, while lilies of the group *L. bulbiferum* are almost invariably sterile with their own pollen, they are readily fertilized by pollen from any other individual of the same group. The same is the case with *Hemerocallis flava*, and probably all other species except *H. minor*.

A hybrid is readily obtained between *Tragopogon pratense* and *T. porrifolium*.

The two species of *Melilotus*, *M. albus* and *M. macrorhizus*, the one white, the other yellow, are both freely visited by honey-bees, which, as a rule, confine themselves rigorously to flowers of one colour on the

* Ann. Jard. Bot. Buitenzorg, ix. (1890) pp. 41–119 (10 pls.). Cf. this Journal, 1889, p. 780.

† SB. K. Bayer. Akad. Wiss. München, 1890, pp. 105–379.

‡ Abhandl. Naturw. Ver. Bremen, xi. (1890) pp. 413–22. See Bot. Centralbl., xliii. (1890) p. 34.

same journey. It is, however, possible to obtain hybrids between the two species, and then the standard is always white, and all the remainder of the corolla yellow.

A possible case of parthenogenesis in *Bryonia dioica* is recorded.

Fertilization of Caryophyllaceæ.*—Prof. E. Warming describes the structure of the flowers of a large number of Scandinavian and Arctic Caryophyllaceæ, especially in relation to the mode of pollination.

Honey was found in all the species examined. The flowers are usually proterandrous; the stamens borne on the sepals are developed first, then those borne on the petals, and finally the stigmas; proterogyny occurs in a few species, and is apparently correlated with the reduction of the petals. The author confirms the observation of Müller that the degree of proterandry is in proportion to the size of the flower; but the arctic species, even when large-flowered, are more inclined to homogamy than those from lower latitudes. Self-pollination is frequent, and results in perfect fructification; anemophily is very rare, but occurs in *Silene Otites*. Many homogamous species are pleogamous, and these are generally gynodiœcious; this the author regards as not advantageous, but rather as a degeneration, caused by external or internal conditions. The larger flowers are usually hermaphrodite, while the smaller flowers are more or less reduced. Cleistogamous flowers are not uncommon. In many species the flowers remain closed in dark and cold weather, and are then self-fertilized. He does not find that the female are more fertile than the hermaphrodite flowers.

Fertilization of Araceæ.†—Prof. G. Arcangeli describes the phenomena connected with the opening of the inflorescence of *Helicodiceros muscivorus* (Araceæ). The first day of the expansion of the spathe, he found imprisoned within it as many as 378 insects, of which 371 were Diptera, and 7 Coleoptera. From the entire absence of any digestive glands on the inner surface of the spathe, or any other organs for the absorption of nutritive material, he rejects Schnetzler's explanation that the dead bodies of the insects serve for the nutrition of the plant, and believes that they assist in the process of pollination.

Returning to the fertilization of *Dracunculus*, Prof. Arcangeli‡ adduces additional facts in favour of his view that the flowers of *D. vulgaris* are pollinated chiefly by necro-coleoptera. He was able to effect impregnation by the artificial introduction into the inflorescence of specimens of *Saprinus* and *Dermestes* which had already been pollinated.

Artificial Germination of Milk-weed Pollen.§—Prof. B. D. Halsted has been able to germinate the pollen-grains which constitute the pollinia of *Acerates viridiflorum* (Asclepiadeæ) by immersing them in agar, and was able to watch the very beautiful movements of protoplasm within the pollen-grain after it has put out its tube. These consist of a continuous current round the large vacuoles. The same phenomenon was observed in various species of *Asclepias*.

* Bot. Foren. Festskr. (Copenhagen), pp. 194–296 (29 figs.).
† Nuov. Giorn. Bot. Ital., xxii. (1890) pp. 467–72.
‡ Malpighia, iv. (1890) pp. 254–61. Cf. this Journal, 1890, p. 629.
§ The Microscope (Trenton, N. J.), x. (1890) pp. 229–31 (4 figs.).

Abnormal Germination of Acer platanoides.*—M. L. J. Léger finds that in about 4 per cent. of the instances examined the germination of the seeds of *Acer platanoides* was abnormal; the irregularity was in the following directions:—(1) one of the two cotyledons was more or less bifid; (2) the number of cotyledons was three; (3) each of the two cotyledons was split for 1/3 of its length; (4) the number of cotyledons was four. The structure of the cotyledons is described in each of these cases, especially in regard to the arrangement of their vascular bundles.

Dissemination of the Seeds of Harpagophyton.†—Herr P. Ascherson calls attention to the remarkable way in which the seeds of *Harpagophyton* (Pedaliaceæ) are disseminated in South Africa. The seed-vessels growing on the prostrate branches are covered with hooked appendages, which become fixed in the hoofs of antelopes and cattle. The violent stamping of the animal to get rid of the annoyance splits the hard pericarp and scatters the seeds. The characteristic hooked bristles on the seed-vessels are found even in the aquatic genus of the order, *Trapella.*‡ *Sesamum Schinzianum* is characterized by the unusual occurrence on the same species of both extra-floral nectaries and a viscid hairy covering of the axis.

(2) Nutrition and Growth (including Movements of Fluids).

Relations between Host and Parasite.§—Prof. H. Marshall Ward discusses some of the relations between host and parasite in certain epidemic diseases of plants. He shows that the conditions which are unfavourable to the vitality of the host are, in general, favourable to the rapid development and propagation of the fungus-parasite, causing especially thinness and softness in the cell-walls, and a greater permeability and less resistance in the protoplasm, with a larger proportion of organic acids, glucoses, and soluble nitrogenous constituents in the cell-sap. In the case of some of the fungi which are most destructive to plants, while the botrytis-form is saprophytic, the mycele is truly parasitic in the tissues of the host; and this latter is especially vigorous and destructive where the botrytis-form has had abundant food-material to live upon. In addition to a ferment or enzyme, the hyphæ of the mycele have the power of developing large quantities of oxalic acid, which is especially destructive to the protoplasm of the host. Whether a given fungus exists as a parasite or as a saprophyte is, to a large extent, a question of nutrition.

Parasitism of Orobanche.‖—Dr. G. Ritter Beck von Mannagetta gives the characters of the 13 genera of the order Orobancheæ, and a complete monograph of the 82 species of *Orobanche.* With regard to their parasitism, he finds that, while a few species—*O. Laserpitii, Hederæ,* and *Artemisiæ*—are known only on a single host-plant, a much larger number grow on many indifferently, *O. minor* on as many as 58 species. The natural orders to which the greatest number of the host-plants belong

* Bull. Soc. Linn. Normandie, 1888–9 (1890) pp. 199–223 (1 pl.).
† Verhandl. Bot. Ver. Brandenburg, xxx. (1889) pp. ii.–v.
‡ Cf. this Journal, 1888, p. 992.
§ Proc. Roy. Soc., xlvii. (1890) pp. 393–443 (16 figs.).
‖ Luerssen u. Haenlein's Biblioth. Bot., Heft 19, 1890, 275 pp. and 4 pls.

are Leguminosæ and Compositæ. With the exception that some hosts seem more favourable to the growth of the parasite than others, the same species of *Orobanche* growing on different host-plants presents no perceptible difference of any kind. On the other hand, they inflict great injury on many cultivated crops, especially hemp, clover, and tobacco.

Phanerogamic Parasites.*—Dr. F. Johow gives a summary of all that is at present known with regard to parasitic flowering plants, which he classifies under four heads, viz.:—Euphytoids, which have developed from ordinary terrestrial autotrophous plants (Loranthaceæ, most Santalaceæ, Rhinantheæ, Orobancheæ, &c.); (2) Lianoids, developed from climbing plants (*Cuscuta*, *Cassytha*); (3) Epiphytoids, those that resemble epiphytes except in their parasitic habit (Loranthaceæ, some Santalaceæ); (4) Fungoids, which present no relationship with any autotrophous group (Balanophoraceæ, Cytinaceæ). Each of these classes, except the last, may be again divided into Holoparasites and Hemiparasites. Some again are obligatory, and others facultative parasites. The total number of species known is somewhat over a thousand, of which about one-half belong to the Loranthaceæ.

As regards the choice of a host, some species grow only on a single host-species, as *Loranthus aphyllus* on *Cereus peruvianus*, *Cuscuta Epilinum* on the flax; others only on different species of the same genus; others only on different genera of the same family; while others again have no such restrictions. Some again choose in preference different hosts in different districts; thus, for example, the mistletoe grows in some regions almost exclusively on the apple, in others on the pine; *Arceuthobium Oxycedri* only on *Juniperus Oxycedri* in Europe; in North America on different species of *Pinus*. Many parasites confine their attacks to special parts of the host-plant; as the Loranthaceæ entirely to branches, the Balanophoraceæ entirely to roots. The organ for the absorption of nutriment is, in all except the Cytinaceæ, differentiated haustoria, which are apparently, from a morphological point of view, metamorphosed roots. In the Cytinaceæ the entire vegetative structure of the parasite, imbedded in the interior of the host, serves as a haustorium.

A special description is also given of the mode of parasitism in the different groups; and the species or genera belonging to each are enumerated.

Rooting of Bulbs and Geotropism.†—M. H. Devaux states that the anomalous method of rooting by means of stalked bulbs in the common tulip has been observed by Germain de Saint Pierre, Irmisch, and Royer. But this method of rooting is not confined to the tulip. In various species of *Allium*, *Muscari*, *Scilla*, *Hyacinthus*, *Calystegia*, *Sagittaria*, *Tamus*, &c., one or more internodes of the stem may become enlarged, and thrust vertically into the ground by their free extremity; this extremity bears a bud which is destined to be transformed into a bulb or tubercle. This phenomenon appears to be the result of geotropism.

* Verhandl. Deutsch. Wissensch. Ver. Santiago, ii. (1890) pp. 68-105 (10 figs.).
† Bull. Soc. Bot. France, xxxvii. (1890) pp. 155-9.

Assimilation and Respiration.*—Prof. Kreusler has determined, from experiments chiefly on the bramble and cherry-laurel, that the optimum temperature for the exhalation of carbon dioxide is about 45° C., a rise of 5° above this showing a considerable diminution in the energy of the respiration; he finds no confirmation of the theory of a "post-mortal" respiration. The assimilating energy shows no considerable variations between 15° and 30° C.; above 30° it begins gradually to diminish, falling to zero at a temperature between 45° and 50° C.

Assimilation by Red Leaves.†—From observations on the red varieties of the beech, the birch, and the sycamore, M. H. Jumelle concludes that in trees with leaves of a red or copper colour, chlorophyllous assimilation is always less intense that in the same trees with green leaves; in the case of the copper-beech and purple sycamore, this is reduced to one-sixth of the normal amount.

Influence of high altitudes on Assimilation and Respiration.‡—As the result of a series of experiments on a number of species, chiefly herbaceous, Prof. G. Bonnier finds that in the same plants, placed in the same external conditions, the specimen grown in an alpine climate modifies its functions by the augmentation of chlorophyllous assimilation and transpiration, while respiration and transpiration in the dark appear to be scarcely affected by the change.

Permeability of Wood to Air.§—M. Krutícki distinguishes in this respect three classes of wood, viz. (1) Those which present great permeability, as the oak and poplar, in which the air can penetrate under a pressure of from 3 to 10 mm. of mercury; (2) Those of low permeability, like the birch and maple, which require a pressure above that of the atmosphere; and (3) Those of moderate permeability, which are very numerous. The air contained in the branches has not always the same composition; in winter it contains less oxygen than the atmospheric air, but a larger proportion of nitrogen, and especially of carbonic acid; with the commencement of spring, the proportion of oxygen increases, while that of carbon dioxide diminishes, so that when the buds expand, the composition of the imprisoned air is very nearly that of the atmosphere.

(3) Irritability.

Action of Water on Sensitive Movements.‖—M. H. Léveillé gives the details of an experiment on this point with *Mimosa rubricaulis;* the following conclusion was arrived at:—plants, if placed under water, retain their sensitiveness as long as they retain any vigour.

Movements of the Leaves of Porlieria hygrometrica.¶—Dr. G. Paoletti states that the diurnal movements of the leaves and leaflets of this plant (Zygophyllaceæ) is due to unequal turgidity of the two cells

* SB. Niederrhein. Gesell. (Verhandl. Naturhist. Ver. Preus. Rheinl.), lxxiv. (1890) pp. 54–60.

† Comptes Rendus, cxi. (1890) pp. 380–2.

‡ T. c., pp. 377–80; cf. this Journal, 1890, p. 486.

§ Script. Bot. Hort. Univ. Imp. Petropolitanæ, ii. See Bonnier's Rev. Gen. de Bot., ii. (1890) p. 324.

‖ Bull. Soc. Bot. France, xxxvii. (1890) p. 153.

¶ Malpighia, iv. (1890) pp. 31–40.

which compose the primary and secondary motor nodes (those of the entire leaf and of the leaflets), caused by the greater amount of light and heat to which the upper one of the two is subject in the morning. If exposed either to continuous darkness or to continuous light, the movements will continue for some days, but with decreasing energy, and will finally cease altogether.

(4) Chemical Changes (including Respiration and Fermentation).

Formation of Albuminoids.*—In order to test the correctness of the theory that the chromatophores are the seat of the synthesis of the albuminoids in plants, M. Chrapowicki cultivated plants of *Phaseolus vulgaris*, *Cucurbita Pepo*, and *Zea Mays* in a non-nitrogenous saline solution obtained by replacing the potassium and calcium nitrates in Knop's solution by potassium chloride and calcium sulphate. The development was at first normal, but was soon retarded and finally entirely arrested. The leaves were cut off and placed in normal Knop's solution, and the formation of the albuminoids watched under the Microscope. They were formed at the expense of the nitrates in the solution, and always made their appearance first in the chromatophores.

γ. General.

Action of Solar Heat on the Floral Envelopes.†—M. E. Roze has endeavoured to determine by experiment whether the direct effect of the sun's heat varies with the different colours of flowers. When a flower which has opened in the shade is suddenly exposed to solar radiation, it absorbs at first a certain quantity of heat, then rapidly gives off a large portion of this caloric, and, if then again placed in the shade, gradually loses the absorbed heat, and places itself in equilibrium with the temperature of the surrounding air. Red or violet floral envelopes absorb and give off more rays of heat than blue or yellow, and these latter more than white. A thermometer placed over the first rises, when transferred from the shade to the sun, as much as 8°; one over the second 6°–7°; over the third 5°–6°; while over green leaves it does not rise more than from 2° to 3°. These latter absorb as much heat as petals, but give off again only a small quantity. This radiation of heat from the petals has probably a great effect in promoting the dehiscence of the anthers. The author found also that heat is powerfully absorbed by the soil from the sun's rays, and is given off again to the whole plant, and especially to the parts in contact with the earth. A thermometer placed above the prostrate leaves of *Plantago major* rose to 44°, and in the case of *Hypochæris radicata* to 46°, while the temperature of the surrounding air was only 28°.

Biology of the Ericaceæ.‡—M. L. Fliche has examined various species of Ericaceæ with a view to determine the quantity of mineral elements which they require. He finds that the plants belonging to

* Arb. St. Petersburg Naturf. Gesell., xviii. See Bonnier's Rev. Gén. de Bot., ii. (1890) p. 359.

† Bull. Soc. Bot. France, xxxvi. (1889), Actes du Congrès de Bot., pp. ccxii.–ccxiv.

‡ Rev. des Eaux et Forêts, Nov. 10, 1889. See Bull. Soc. Bot. France, xxxvii. (1890), Rev. Bibl., p. 107.

this order can be classed under two categories, calcifugous and calcicolous; the composition of the ash being nearly uniform in each class; but the difference between the two is very pronounced, although some genera, such as *Erica*, have representatives in each group. In the calcifugous species, e. g. *Erica cinerea*, *Calluna vulgaris*, the proportion of silica in the ash is very high, sometimes exceeding 30 per cent., while that of lime is not more than 20 per cent.; in the calcicolous species such as *E. multiflora*, the proportion of silica is not more than 13 per cent., while that of lime may be as much as 31, and that of potassa as much as 22 per cent.

Myrmecophilous Plants.*—Herr K. Schumann describes a number of fresh myrmecophilous trees and shrubs, chiefly from the East Indian Archipelago, viz.:—*Gmelinia* (*Vitex*) *macrophylla* (Verbenaceæ); among Rubiaceæ *Remijia physophora* and *Nauclea lanceolata*, where the ants inhabit chambers in the stem, and *Myristica heterophylla* sp. n.

B. CRYPTOGAMIA.

Cryptogamia Vascularia.

Sphenophyllum and Asterophyllites.†—From examination of a specimen from the Carboniferous strata of Silesia, Mr. A. C. Seward concludes that *Asterophyllites* is not a distinct genus of Vascular Cryptogams, but that it must be regarded as a morphological condition of *Sphenophyllum*, with reduced leaves having only a single vein.

Muscineæ.

Peristome.‡—M. Philibert now brings to a close his discussion of the differences between the Nematodonteæ and the Arthrodonteæ, and the transitions between these two groups. The following are the author's conclusions:—That the Nematodonteæ attain their highest degree of development in the Polytrichaceæ, having probably passed through a series of stages of less complexity, corresponding to the series of Dawsonieæ. The Arthrodonteæ give rise to a great variety of forms. The Leptostomeæ and the Splachnaceæ appear to have preserved traces of forms transitional between the Nematodonteæ and the Diplolepideæ; the Funariaceæ and the Orthotrichaceæ resemble the latter in certain characters. There is also an affinity between the genera *Splachnum* and *Bryum*; and to the Bryaceæ belong the Hypnaceæ, and all the Pleurocarpeæ, whose development has been posterior to that of other mosses.

Microspores of Sphagnaceæ.§—Herr S. Nawaschin maintains that the so-called microspores of certain species of *Sphagnum* belonging to the *acutifolium* group are not organs of the moss itself, but are spores of a parasitic fungus belonging to the Ustilagineæ, probably an undescribed species of *Tilletia*.

Javanese Hepaticæ.‖—Under the name *Treubia* Prof. K. Goebel describes a new genus of Hepaticæ from Java, belonging to those

* Verhandl. Bot. Ver. Brandenb., 1890, pp. 113–23. Cf. this Journal, 1890, p. 486.
† Mem. and Proc. Manchester Lit. and Phil. Soc., 1890 (3 figs.).
‡ Rev. Bryol., xvii. (1890) pp. 39–42. Cf. this Journal, 1890, p. 488.
§ Bot. Centralbl., xliii. (1890) pp. 289–90.
‖ Ann. Jard. Bot. Buitenzorg, ix. (1890) pp. 1–40 (4 pls.).

which form a link between the thalloid and the foliose forms. While the leaves are the largest known among Hepaticæ, the position of the sexual organs (archegones only have at present been observed) allies it with the thalloid forms. The cells of the stem are infested by a parasitic, or possibly symbiotic, fungus.

Colura ornata sp. n. is epiphyllous; the water-sack characteristic of the genus is surmounted by a comb-like projection from the surface of the leaf. A species of *Plagiochila* with water-sacks is also described.

Kurzia crenacanthoidea, described by its discoverer as an alga, is in reality a species of *Lepidozia* with confervoid habit.

Characeæ.

Histology of Characeæ.*—Dr. W. Overton's researches on this subject relate mainly to two points:—

(1) The nature of the spiny bodies found in the cells. The species examined for this purposes was chiefly *Nitella syncarpa*. They were found in all the mature internodes of the stem and leaves, where they obtain a diameter of 22 to 24 μ in the young oospheres, in the cortical cells of the oosperm, in the shield-cells of the antherids, occasionally in the manubria, but not in the other cells of the antherids. They are clothed with a distinct membrane, and often occur in dense masses, when they assume a polygonal form. Microchemical reactions show that they are of a proteid nature, and that they frequently contain tannin; they are peculiarly resistant to the action of acids, even when concentrated. They may be compared to a certain extent with aleurone-grains. The living cells of young internodes contain also a number of hyaline vesicles imbedded in the protoplasm, which are also clothed with a distinct membrane, and are clearly of a similar nature to the spiny bodies. In the species of *Chara* examined (*C. fragilis* and *hispida*) no structures were found resembling either of those above described.

(2) The structure of the hard envelope of the oosperm. This envelope is not lignified in the correct sense of the term; i. e. it does not show the microchemical reactions of lignin, but rather those of cuticularized and suberized membranes. After removal of the calcareous deposit, the envelope of the oosperm of *Chara fragilis* consists of three layers:—the outermost is nearly black, is furnished with spiral thickening-bands, and bears a number of short spines; the middle layer is brown and smooth; the innermost is the true membrane of the oosperm, is light brown and transparent, and is but slightly cuticularized.

Algæ.

Algæ of Behring's Sea.†—Herr F. R. Kjellman describes the sea-weeds of this sea, which are partly of an Arctic, partly of a more southern character, with some peculiar to the region. Several new species are described, and one new genus of Phæosporeæ, *Analipus*, with unilocular zoosporanges, a horizontal almost crustaceous thallus, from which rise the fertile branches, simple, solid below and fistulose above.

* Bot. Centralbl., xliv. (1890) pp. 1–10, 33–8 (1 pl.).

† K. Svensk. Vetensk.-Akad. Handl., xxiii. (1889) 58 pp. and 7 pls. See Bot. Centralbl., xliv. (1890) p. 150.

Sargassum.*—Prof. J. G. Agardh publishes a monograph of this genus of seaweeds, with a description of the different forms assumed by the various organs. 143 species are described, of which 24 are new. The author classifies them under five subgenera, viz.:—*Phyllotricha*, *Schizophycus*, *Bactrophycus*, *Arthrophycus*, and *Eusargassum*, founded generally on the form and disposition of the receptacles. Of the five subgenera, *Schizophycus* comprises only a single species, while 93 are included in *Eusargassum*.

New Genus of Phæosporeæ.†—M. E. Bornet proposes the new genus *Zosterocarpus*, founded on *Ectocarpus Œdogonium* Men., which he separates from *Ectocarpus* with the following diagnosis:—Thallus monosiphonius ramosus; sporangia plurilocularia divisione peripherica articulorum exorta, soros crustiformes orbiculares v. annuliformes in articulis ramulorum formantia; cellulæ singulæ sporangiorum simplices breves haud septatæ apice poro apertæ.

Prasiola and Schizogonium.‡—M. E. de Wildeman considers that it has been established that *Schizogonium* and *Hormidium* are simply forms of development of the same organism. The family Ulotricheæ must therefore be reduced to the genus *Hormiscia* alone of the genera included under it by De Toni, to which should be added *Prasiola*, which the author proposes to remove from Ulvaceæ, and thinks it probable that to it will finally be referred the species at present placed in *Schizogonium*.

Myxochæte, a new genus of Algæ.§—Under the name *Myxochæte barbata*, Herr K. Bohlin describes a new species and genus of green algæ, growing in fresh water, epiphytic on *Vaucheria sessilis*, and nearly allied to *Chætopeltis*. The thallus is discoid, and usually consists of a single layer of cells, is invested in mucus, and each cell is provided with two hyaline bristles; the branches are irregularly aggregated, and each cell contains a single chlorophyll-mass.

Neomeris and Bornetella.‖—Prof. C. Cramer describes a number of species of the verticillate Siphoneæ, chiefly belonging to the above-named genera, viz.:—*Polyphysa Peniculus*, *Botryophora Conquerantii*, *Neomeris Kelleri*, *N. dumetosa*, *Bornetella nitida*, *B. capitata*.

Observation of the structure of the mantle-sheath, and of the mantle-caps, especially in *Neomeris* and in *Bornetella*, lead Prof. Cramer to the conclusion that they are formed by intussusception. By the mantle-cap is meant the upper deciduous, by the mantle-sheath the lower permanent portion of cellulose layers formed over the apical cell between the layers of hairs; this last becomes at length strongly calcified; the others are free from lime. The sporanges and spores are described in both these genera; also cubical crystalloids in the cells of

* Handl. K. Svenska Vetensk.-akad., 1889, 133 pp. and 31 pls. See Bull. Soc. Bot. France, xxxvii. (1890) Rev. Bibl., p. 110.

† Bull. Soc. Bot. France, xxxvii. (1890) pp. 139–48 (1 fig.).

‡ Bull. Soc. Belg. Microscop., vi. (1890). See Notarisia, v. (1890) p. 1035.

§ Bih. K. Svensk. Akad. Handl., xv. (1890) 7 pp. and 1 pl.

‖ Denkschr. Schweiz. Naturf. Gesell., xxxii. (1890) 48 pp. and 4 pls. Cf. this Journal, 1888, p. 464.

the stem of *Botryophora Conquerantii*, and spherocrystals of inulin in sterile specimens of the same species.

Phytophysa.*—Under the name *Phytophysa Treubii*, Mdme. Weber van Bosse describes an epiphyllous alga from Java belonging to the Phyllosiphonaceæ, found on the stems, leaves, leaf-stalks, and buds of a species of *Pilea*, where it causes internal galls. *Phytophysa* resembles *Phyllosiphon* in its manner of living, in part, at least, at the expense of its host. Both are surrounded by a thick membrane; *Phyllosiphon* is rich in grains of starch, *Phytophysa* in grains of cellulose; in both each cell contains a considerable number of minute nuclei. *Phytophysa* is distinguished from *Phyllosiphon* by its spherical form, and by producing galls.

Gonium pectorale.†—Dr. W. Migula has subjected this organism to a careful investigation, and finds that the entire colony, as well as each individual cell, is inclosed in a mucilaginous envelope, often of extreme tenuity, and of nearly the same refrangibility as water. The interstitial space between the envelopes of the separate cells is composed of a central quadrangle and four longer and twelve shorter isosceles triangles. When the colony consists of only four cells, there are two more or less regular usually isosceles triangles, thus presenting a clear distinction from *G. tetras*, in which the four cells are arranged around a nearly square intercellular space. The young colonies are already surrounded by their envelope when they escape from their mother-colony. The protoplasm of the cilia presents somewhat different reactions from that of the cells, and their vibratility is confined to their apical portion. When cell-division is taking place, the cilia of the mother-cell persist often until the sixteen daughter-cells are fully formed. The movement of the colony is of a more trembling nature than that of *Volvox;* and there are no protoplasmic threads connecting the cells. The *Gonium*-colony enters into a resting condition as a result of desiccation, closely resembling that of *Pandorina;* the membranes become thicker and denser, and the cilia disappear, as do finally the pigment-spot and the two cilia. The resting-cells have a diameter of about 12–15 μ; they are dark green, and are filled with a granular endochrome. Each breaks up on germination into four biciliated swarm-cells, closely resembling the cells of an ordinary *Gonium*-colony, but at first wanting the mucilaginous envelope, which, however, is soon formed; these developed, as far as was seen, only into four-celled colonies. In the resting condition the *Gonium*-cells are very liable to be attacked and entirely destroyed by a parasite. The chromatophores break up very readily into a number of very minute chlorophyll-granules.

Fossil Algæ.‡—M. G. Maillard classifies all structures described as fossil algæ under two categories, viz.:—(1) Those which appear as simple half-cylindrical elevations on the under-side of the strata, and are always more or less compressed. (2) Those which can be separated from the rock in which they are imbedded. To the first category, the

* Ann. Jard. Bot. Buitenzorg, viii. (1890) pp. 165-88 (3 pls.).

† Bot. Centralbl., xliv. (1890) pp. 72-6, 103-7, 143-6 (1 pl.).

‡ Mém. Soc. Palæontol. Suisse, xiv. (1887) 5 pls. See Bot. Centralbl., xliii. (1890) p. 126.

algal nature of which is very doubtful, belong the greater number of palæozoic forms, such as *Crossochorda*, *Cruziana*, and *Harlania*, and possibly also *Spirophyton* and *Alectorurus;* in the mesozoic strata, *Helminthopsis*, *Gyrochorte*, and *Cylindrites*, from the Lias ; from the tertiary strata, *Helminthoidea*, *Palæodictyon*, and *Münsteria* from the alpine Flysch. The second category, which he regards as comprised of true fossils, includes *Chondrites* and *Theobaldia*, and probably also *Discophorites* and *Gyrophyllites* from the Jurassic, *Taonurus* and *Nulliporites* from palæozoic strata ; *Chondrites*, *Taonurus*, *Caulerpa*, *Sphærococcites*, *Discophorites*, and *Gyrophyllites* from the chalk ; *Chondrites*, *Caulerpa*, *Tænidium*, *Halymenites*, *Hormosira*, *Sphærococcites*, *Gyrophyllites*, *Nulliporites*, *Aulacophycus*, and *Taonurus* from tertiary strata. As regards the systematic and phylogenetic position of these algæ, he considers that we have very little evidence.

Fungi.

Carbohydrates in Fungi.*—M. E. Bourquelot gives a résumé of the results of his analyses of the genus *Lactarius*. Mannite, volemite, trehalose, and glucose were the hydrocarbons found ; the proportion, however, of these varies from one species to another, and even from one year to another in the same species.

New Ustilagineæ.†—In a general summary of the Ustilagineæ of Denmark, comprising 47 species, Herr E. Rostrup describes the following as new :—*Entyloma Ossifragi*, parasitic on *Narthecium ossifragum*, *E. catenulatum* on *Aira cæspitosa*, *Ustilago Pinguiculæ* on *Pinguicula vulgaris*, *Tuberculina maxima* on *Peridermium Klebahni*, itself parasitic on *Pinus Strobus*.

Dissociation of a Lichen.‡—Sig. U. Martelli records the natural dissociation of a lichen, a variety of *Lecanora subfusca*, into its constituent algal and fungal elements. The central portion of the patches, which were growing on an old wall, were of a deep green colour, caused by large masses of *Protococcus viridis ;* while the periphery consisted of nearly colourless mycelial filaments. The cause of this dissociation appears to be excessive humidity, which prevents the fungus putting out its " crampons " or short filaments which take up the gonids.

Bouquet of Fermented Liquors.§—The opinion long ago expressed by M. Pasteur that the flavour and special qualities of certain wines are due to their particular ferment, finds support from the fact recorded by M. G. Jacquemin, who, in endeavouring to impart flavour to barley wine by making it from wort leavened with the special ferments of wines of delicate flavour, found that the sugar-water in which the ferment was kept obtained the exact flavour of the various wines used, such as Champagne or Burgundy. He also imparted the flavour of apples and pears by using their ferments in barley wort.

* Bull. Soc. Mycol., v. See Rev. Mycol., xii. (1890) p. 192. Cf. this Journal, 1890, p. 644.

† 'Ustilagineæ Daniæ,' Kjöbenhavn, 1890, 52 pp. See Bot. Centralbl., xliii. (1890) p. 388. ‡ Nuov. Giorn. Bot. Ital., xxii. (1890) pp. 450-1.

§ Comptus Rendus, cx. (1890) pp. 1140–2.

Indian Rusts and Mildews.*—According to Dr. A. Barclay, the most prevalent form of rust on wheat, barley, and oats in India, is not *Puccinia graminis*, but *P. rubigo-vera*; the æcidio-form appears to occur on *Berberis Lycium*. The following rusts occurring in India are also described:—*Puccinia Sorghi* on *Sorghum vulgare*, *Melampsora Lini* on flax, *Uromyces Pisi* on *Cicer arietinum* and on *Lathyrus sativus*, *Puccinia Fagopyri* on buckwheat.

Puccinia digraphidis.†—By culture experiments, Mr. H. T. Soppitt has proved that the æcidium of *Convallaria majalis* known as *Æcidium Convallariæ* is a heterœcious Uredine, and that the host which bears the uredo- and teleuto-spores is *Phalaris arundinacea*. For the uredospore generation he proposes the name *Puccinia digraphidis*.

New Ramularia on Cotton.‡—Under the name *Ramularia areola*, Prof. G. F. Atkinson describes a new parasitic fungus forming brown spots on the under side of the leaves of the cotton-plant in Alabama.

Uredo notabilis.§—Among other new fungi from Australia, Herr F. Ludwig describes this remarkable species of *Uredo*, parasitic on the phyllodes of *Acacia notabilis*. It causes conspicuous inflated bladders, as much as three cm. in diameter; the epispore of the uredospores is distinguished by its remarkable reticulate sculpture, so that they might readily be taken for teleutospores.

A beautiful new *Clathrus*, *C.* (*Ileodictyon*) *Tepperianus*, is also described from South Australia.

Æcidium Schweinfurthii.‖—Under this name Herr P. Hennings describes a remarkable new species of parasitic fungus which causes large galls on the ovary or young fruit of *Acacia fistula* in Central Africa.

New Type of Dermatomycosis.¶—M. R. Blanchard describes a disease in the skin of a green lizard, in the form of tumours produced by a mucedineous fungus belonging to the genus *Fusarium* or *Selenosporium*. The tumours are permeated throughout by septated conids springing from mycelial filaments of two kinds, acrogenous, and springing laterally from the mycele. The author regards this as an example of a fungus ordinarily saprophytic, which becomes parasitic under exceptional conditions.

Phalloideæ.**—Dr. E. Fischer gives a complete account of the history of development of the Phalloideæ, which begins with the broadening of the end of a hyphal bundle, in which the central bundle and the volva-jelly are formed as denser portions of the tissue, while between these there remains an intermediate tissue which is not at once differentiated. The first differentiations of this intermediate tissue bring about the variations in the form and structure of the receptacle, and of the distribution of the glebe, which afford specific characters. From this

* Journ. of Bot., xxviii. (1890) pp. 257–61 (1 pl.). † T. c., pp. 213–6.
‡ Bot. Gazette, xv. (1890) pp. 166–8 (4 figs.).
§ Bot. Centralbl., xliii. (1890) pp. 5–9 (2 figs.).
‖ Abhandl. Bot. Verein. Brandenburg, xxx. (1890) pp. 299–300.
¶ Comptes Rendus, cxi. (1890) pp. 479–82.
** Denkschr. Schweiz. Naturf. Gesell., xxxii. (1890) 103 pp. and 6 pls. See Bot. Ztg., xlviii. (1890) p. 496.

point the development of the receptacle is very uniform. As regards classification, the author first divides the Phalloideæ into the Clathreæ and Phalleæ; *Kalchbrennera* being nearly related to the former. The genera are then described in detail, many of those belonging to the Clathreæ passing gradually one into another.

New Genera of Basidiomycetes.* — In a critical account of the Gasteromycetes and Hymenomycetes of Finland, comprising 1255 species, Herr P. A. Karsten describes, in addition to a large number of new species, the following new genera:—*Phisisporinus* (Polyporeæ, separated from *Poria*), *Onnia* (Polyporeæ, separated from *Polyporus*), *Elfvingia* (Polyporeæ, from *Fomes*), *Kneiffiella* (Grandinieæ, from *Hydnum*), and the following under Thelephoreæ:—*Lomatia* (separated from *Thelephora*), *Sterellum* (from *Stereum*), *Chætocarpus* (from *Thelephora*), *Trichocarpus* (from *Xerocarpus*), *Cryptochæte* (from *Thelephora* and *Corticium*), *Phanerochæte* (from *Thelephora*), *Peniophorella*, *Hymenochætella*, *Glœocystidium* (from *Grandinia*), *Diplonema*, *Coniophorella* (from *Hypochnus*), *Hypochnopsis* (from *Hypochnus* and *Lyomyces*).

Protophyta.

α. Schizophyceæ.

Defensive Structure of Diatoms.†—Continuing his observations on this subject, Dr. D. Levi-Morenos classifies the general forms of diatoms under three heads, viz.:—(1) Spherical, with polyhedral, conical, and cylindrical derivatives. (2) Fusiform, with naviculoid and bacilliform derivatives. (3) Irregular, with bi-, tri-, and pluripolar derivatives. In each group those forms appear to have specially survived which were best calculated, in the modes already indicated, either to resist being swallowed by aquatic animals, or, if swallowed, to emerge rapidly and uninjured from the intestinal canal.

Pelagic Diatoms.‡—Sig. O. E. Imhof has examined the pelagic flora of the Lake of Zürich at depths varying from 30–60 metres, and finds diatoms at all these depths, accompanied by a few Nostocaceæ, Oscillariaceæ, and Chroococcaceæ, and by abundance of Schizomycetes. At a depth of 60 metres the following diatoms were found,—*Asterionella formosa*, *Nitzschia pecten*, *Synedra longissima*, *Cymatopleura elliptica*, *Diatoma* sp., *Fragillaria* sp., and *Cyclotella* sp.; while at a depth of 100 m. *Anabæna circinalis* was abundant. The numbers of the two first-named diatoms were greater at a depth of 80–90 m. than at lesser depths.

β. Schizomycetes.

Drawings of Bacteria.—The authorities of the Natural History Museum, South Kensington, have placed in the central hall of that institution a small temporary exhibit, consisting of a set of highly magnified drawings of bacteria. It includes such prominent forms as *Bacillus tuberculosis* Koch and the bacillus of fowl-cholera, and is the work of Dr. W. Migula.

* 'Kritisk Ofversigt af Finlands Basidsvampar,' Helsingfors, 1889, 470 pp. See Bot. Centralbl., xliii. (1890) p. 383.

† Notarisia, v. (1890) pp. 1007–14, 1092–6. See this Journal, 1890, p. 650.

‡ Notarisia, v. (1890) pp. 996–1000.

Researches on Micro-organisms.*—Dr. A. B. Griffiths in the third part of his communications deals first with the alkaloids of living microbes, the origin of which is not yet thoroughly understood. In examining the action of certain antiseptics and disinfectants on microbes, he found that *Bacillus tuberculosis*, *B. subtilis*, *B. œdematis maligni*, *Bacterium allii*, or Beneke's *Spirillum* may have their growth inhibited by three per cent of salicylic acid. Various microbes are capable of being dried up in the dust of the atmosphere for several months without losing their vitality. Observations have been made on the effect of cold and of electrical currents, and the latter were proved to be powerful germicides.

There are a larger number of micro-organisms in the summer than either in the spring or winter, and they appear to reach their maximum during the month of August. The number in the air decreases as one ascends. There are more in crowded than in less densely populated centres, and there are fewer when the air is at rest than at any other time. Dr. Griffiths thinks that the most rational method of treating contagious diseases where microbes reside in the blood is by the injection of some germicidal agent.

Milk and Coffee, and their Relation to Microbes.†—M. Miquel gives a résumé of his observations on the number of microbes present in milk. In a cubic centimetre of milk, on its arrival at the laboratory, which was two hours after it had been taken from the cow, 9000 bacteria were found. In another hour 31,750 were found, while in 25 hours there were over 5,000,000. The number of microbes varies much with the temperature; for example, if the milk is raised 25°, the number of germs is enormous. The greater part of these microbes are innocuous; many probably aid in the digestion of the milk. It has been pointed out that an infusion of coffee possesses antiseptic properties, and that typhoid bacilli and erysipelas bacilli cannot live more than a certain time in it; and in the case of cholera the bacillus can only resist it for a short period.

Septic and Pathogenic Bacteria.‡—From an examination of the water which is believed to have caused an outbreak of typhoid fever at Springwater, New York, Mr. G. W. Rafter and Mr. M. L. Mallory have come to the conclusion that septic bacteria are inimical to pathogenic bacteria, and may even be used to destroy them.

Contribution to the Study of the Morphology and Development of the Bacteriaceæ.§—M. A. Billet confines his remarks to four members of the Bacteriaceæ, and more particularly to the zooglœa of *Cladothrix dichotoma*, which, on account of its ramified appearance, obtained the name *Zooglœa ramigera*. The existence of this definite zooglœic form induced Dr. Billet to search among the other Bacteriaceæ for this particular stage, and he was fortunate enough to be able to find a definite

* Proc. Roy. Soc. Edinb., xvii. (1889–90) pp. 257–70.

† Rev. Mycol., xii. (1890) pp. 199–200.

‡ 'Report on the Endemic of Typhoid Fever at Springwater, N.Y.,' 1890, 21 pp. and 3 pls.

§ Bull. Scient. France et Belg., 1890, 288 pp. See Rev. Mycol., xii. (1890) pp. 187–8.

zoogloeic form in three other species — *Bacterium osteophyllum* and *B. Balbiani* spp. nn., and *B. parasiticum*.

Red Bacillus from River Water.*—Prof. A. Lustig describes a bacillus which secretes a red pigment and liquefies gelatin. In plate-cultivations of 8 per cent. pepton-gelatin, colonies developed in 48 hours. In the centre of the colonies the pigment is first observed. In less than three days the pigment had spread to the periphery, and in 4–6 days the whole of the gelatin had become liquid, forming a sticky mass. Cultivations were also made in agar, potato, blood-serum, bouillon, and milk, in all of which the characteristic raspberry-red pigment was developed. No development took place in distilled water, although the vitality of the organism remained, as was shown by inoculating gelatin after the water had remained unclouded for months.

The bacillus grew with the formation of pigment in the absence of oxygen and in presence of hydrogen.

The individual elements are 1·8–3·0 μ long, and about half that in breadth.

Endogenous spore-formation was never observed, nor could such spores be demonstrated by any method of staining, and reproduction was evidently by arthrospores. The pigment was extracted from potato cultivations by scraping off the growth, rubbing it up with a few drops of strong acetic acid, and then treating it with ether until all the pigment was dissolved. The ether was then allowed to evaporate spontaneously. The pigment thus obtained was of a violet-red colour, insoluble in water, but soluble in acetic acid, alcohol, benzin, ether, and chloroform, and was of course altered or discharged by the various decolorizing reagents.

This bacillus, which was obtained from river water in Piedmont, is believed by the author to be distinct from the red bacillus of Eisenberg, which is aerobic and is said to be endosporous. The red bacillus of Frank is endosporous, and that of Fraenkel developes a red-yellow pigment.

New Marine Schizomycete, Streblothricia Bornetii.†—This new genus of Bacteriaceæ, described by M. L. Guignard, forms small colourless zoogloeæ about the size of a pin's head, and having a characteristic shape. They are found in clefts of sea-washed rocks; in their external aspect they bear some resemblance to Nostocaceæ, and in their manner of growth to the Rivulariaceæ, but possess neither spores nor heterocysts. Within the zoogloea-jelly are radiating filaments about 1 μ thick, which at first are straight and closely packed, but afterwards become intertwined, forming a confused mass. These filaments are made up of approximately isodiametric members with finely granular contents inclosed in a pretty thick membrane.

Non-formation of Pigment by Bacillus of Blue Milk.‡—Like *Bacillus prodigiosus* and *pyocyaneus*, which, when cultivated under unfavourable circumstances, lose their power of forming their specific

* Centralbl. f. Bakteriol. u. Parasitenk., viii. (1890) pp. 33–40.

† Comptes Rendus Soc. Biol., xliii. (1890) p. 383. Cf. Centralbl. f. Bakteriol. u. Parasitenk., viii. (1890) p. 465.

‡ Centralbl. f. Bakteriol. u. Parasitenk., viii. (1890) pp. 455–7.

pigment, so the bacillus of blue milk is found to become in similar circumstances incapable of developing its characteristic pigment. Of this defect Dr. P. Behr narrates four examples. The specimens were obtained from cultivations made by competent observers. These four achromatic species were cultivated by the author on various media, such as gelatin, agar, potato, milk, and the results are compared in a series of four tables. This loss of the chromogenic function is possibly only a temporary aberration.

Colour and Pathogenic Differences of Staphylococcus pyogenes aureus and S. albus.*—MM. Lannelongue and Achard attack the view expressed by Rodet and Courmont, that *Staphylococcus pyogenes aureus* is identical with *S albus*, and that the one easily passes into the other. Although *S. aureus*, even in fresh cultivations and in old ones, frequently loses its colour, yet this colour can always be obtained again by breeding from a fresh cultivation, while the white can never be thus changed into orange.

The pathogenic properties of the two micro-organisms are of different intensity, those of *S. aureus* being much stronger than those of *S. albus*.

Acid- and Alkali-formation by Bacteria.†—Dr. T. Smith gives details of some interesting experiments corroborative of the influence of sugar in causing the formation of acid in certain bacterial cultivations. Hog cholera bacillus β was inoculated on four media:—(1) Pepton bouillon; (2) pepton bouillon with one drop of 10 per cent. glucose solution; (3) pepton bouillon with two drops sugar solution; (4) pepton bouillon with four drops sugar solution. In twenty-four hours (1) was slightly alkaline, (2) and (3) were slightly acid, and (4) strongly acid. After seven days (1), (2), and (3) were alkaline, but (4) remained acid.

A similar set of experiments was made with typhoid bacillus. In 24 hours all were distinctly acid. After 10 days the sugarless solution had become alkaline, the other three remaining acid.

The inference from these observations seems to be that by the judicious addition of small quantities of sugar an increased growth of many alkali-forming bacteria may be induced, the acid derived from the sugar diminishing the alkalinity of the cultivation.

Germicidal Action of the Blood in different conditions of the organism.‡—The experiments of A. Rovighi embraced the germicidal property of normal blood, that of definite disease, and that where the condition was merely febrile. Experiments were also made to determine the optimum temperature of germicidal action. By employing Buchner's method, the following results were obtained. The blood of healthy men possesses the property of completely destroying the typhoid bacillus, while on *Staphylococcus pyogenes aureus* and Friedländer's pneumobacillus it exerts a transient and less energetic action.

In blood taken from pneumonia patients, the germicidal influence

* La Semaine Méd., 1890, No. 25. See Centralbl. f. Bakteriol. u. Parasitenk., viii. (1890) p. 429.

† Centralbl. f. Bakteriol. u. Parasitenk., viii. (1890) pp. 389-91.

‡ Riforma Med., vi. (1890) p. 656. See Centralbl. f. Bakteriol. u. Parasitenk., viii. (1890) p. 561.

(Friedländer's pneumo-bacillus, *St. pyogenes aureus*, typhoid bacillus) appears to be considerably diminished or altogether absent. In the blood of severe dyscrasias it is retained.

The blood of rabbits which had been kept at a temperature of 41°–42° until they became notably hyperthermic, destroys a larger quantity of typhoid bacilli, bacilli of rabbit septicæmia, and of *St. pyogenes aureus* than the blood of normal rabbits. The germicidal action of the normal blood of men and rabbits on typhoid bacillus and *St. pyogenes aureus* is slower and less marked at 12° than at 36°. At 42° for *St. pyogenes aureus* it appears to vanish quickly.

Preservation and Sterilization of Milk.*—The preservation and sterilization of milk, when effectual, are attended, says H. Bitter, with several inconveniences, such as the costliness of the process and the loss of the odour and taste of the fluid; these difficulties have been removed by the "Pasteurization" of milk, the object of which is to sterilize milk at temperatures between 65° and 80°, so that while the bacteria are killed, the taste and odour are but little diminished. An essential part of the process is to cool the fluid, immediately after heating, down to 10°–12°, since gradual cooling allows the development of any remaining germs between the temperatures of 40° and 20°. Care must also be taken lest re-infection of the milk take place in the cooler, or in the vessels used for transporting the fluid from place to place.

The author describes and gives an illustration of the apparatus which he has devised for pasteurizing milk.

Nitrification.†—In a second memoir on nitrifying organisms, S. Winogradski gives the results obtained from pure cultivations of the organism isolated by him. This was a colourless elliptical or roundish cell, with a diameter of 1 μ, and is termed by the author *Nitromonas*. This organism, it is found, may grow normally and continue to exert its functions in a medium which contains no trace of any organic carbon compounds. The principal conclusion arrived at is that perfect synthesis of organic material is possible through the action of organic beings, independently of sunlight. Hence it may be said that the life-history of *Nitromonas* is characterized by the phenomena of construction, and in this respect differs from that of other micro-organisms, the functions of which are principally destructive.

Destruction of Anthrax Bacilli in the Body of White Rats.‡—Dr. G. Frank, in answer to the explanation given by Metschnikoff about the disappearance of anthrax in white rats after inoculation under the skin, or in the anterior chamber of the eye, considers that the general validity of phagocytosis is in no way improved by the experiments or the explanation. Objection is taken to inferences drawn from cover-glass preparations as being misleading owing to the well-known difficulty of determining whether a bacillus is above, beneath, or within a cell in cover-glass or hollow slide preparations. This deficiency should be

* Zeitschr. f. Hygiene, viii., No. 2. See Centralbl. f. Bakteriol. u. Parasitenk., viii. (1890) pp. 506–7.

† Annales de l'Institut Pasteur, iv. (1890) p. 257. See Centralbl. f. Bakteriol. u. Parasitenk., viii. (1890) pp. 392–5.

‡ Centralbl. f. Bakteriol. u. Parasitenk., viii. (1890) pp. 298–300.

corrected by sections made through the inoculation spot at various stages of the disease. Had the inventor of phagocytosis done this, the layer of necrotic tissue which separates the bacilli devoted to destruction from the leucocytes would not have escaped his notice. In other words, they are cut off from the organism by certain morbid anatomical conditions produced by the action of the bacilli at the spot in question, the bacilli and the tissue being destroyed by the poison secreted by the micro-organisms.

Penetration of Glanders Bacillus through the intact Skin.*—From inunction experiments made with bacillus of glanders on the uninjured skin of guinea-pigs, M. Cornil concludes that the bacilli gain entrance through the hair-follicles, whence they pass to the cutaneous lymph-spaces. The author infers this from observing that the number of bacilli in the central cavity of the follicle is considerably greater than in the circumjacent connective tissue.

The number of animals treated by inunction (the bacilli were mixed up with some ointment) was fifteen, out of which two contracted the disease. The histological appearances were those of inflammation of the skin, most marked about the follicles. The bacilli were stained with anilin-fuchsin.

Can Bacteria be introduced into the body by being rubbed in through uninjured skin?†—In order to answer this question, M. S. D. Machnoff selected strong anthrax cultivations on agar, and rubbed them into the skin of guinea-pigs. In three cases the agar cultivation alone was used; in four others it was mixed with lanolin. The hair on the back was shorn off short, and the mixture rubbed and pressed in with the finger protected with a caoutchouc cap. All the seven animals died of anthrax in about three days, and in none was there any obvious lesion of the skin. In order to meet the objection that the animals had possibly been infected by inhaling or swallowing the anthrax, three guinea-pigs were smeared over with the lanolin cultivation mixture, and all three remained unaffected. Microscopical sections made from the skin cut out before death where the inunction had been practised, failed to show the presence of bacilli except in small numbers in the hair-follicles, and this only after 48 hours of the rubbing. In sections made from skin removed after death, many, though not all, show accumulations of bacilli in the corium, and these seemed to have distinct relation to the hair-follicles and not to the horny layer of the epidermis. From these observations the author concludes that it is possible that bacteria may be introduced into the animal body through the uninjured skin, and that if so their probable path is through the hair-follicles.

It would have been more satisfactory had mention been made of the skin-glands, and if sections had been made from those parts of the skin where inunction had not been practised.

Effect of Micro-organisms on the Fowl-embryo.‡—Herr M. Lederer, in making experiments as to the transmission of micro-organisms to the

* La Semaine Méd., 1890, No. 22. See Centralbl. f. Bakteriol. u. Parasitenk., viii (1890) pp. 334-5.

† Russkaja Medicina, 1889, No. 39. See Centralbl. f. Bakteriol u. Parasitenk., vii. pp. 441-3.

‡ Mittheil. aus d. Embryol. Institute d. K.K. Universität Wien, 1890, pp. 66-74.

embryo, used freshly fertilized hen's eggs, which were artifically incubated in the usual manner. When development had proceeded for various lengths of time, a small piece of shell and of the shell-membrane was removed, and the embryo inoculated with various micro-organisms; the aperture thus made was closed again, and sealed down with wax and a cover-glass. The micro-organisms used were saprophytes, e. g. pink yeast, *Staphylococcus albus*, *Micrococcus prodigiosus*, *Bacterium violaceum*, and others. About two hundred eggs were inoculated, and in all cases development was stopped, and this result was usually accompanied by decomposition. The author comes to the conclusion that the transmission of infection to the embryo of birds takes place in a manner different from that observed in Mammalia.

Water Bacteria and their Examination.*—Herr A. Lustig has recently published a work on the "diagnosis of water bacteria, with directions for their bacteriological and microscopical examination." In dealing with these micro-organisms, the author first treats of those pathogenic to man, next those that are noxious to animals, and thirdly those which are harmless; the series is further subdivided into cocci, bacilli, and spirilla. Although there is a copious literature of water bacteria, yet, as it is much scattered, this work, which brings together the descriptions and results of many writers, cannot fail to be useful, more especially as the diagnosis tables are accompanied by practical directions for the bacteriological investigation of water.

Action of Products secreted by Pathogenic Microbes.†—The work of M. Bouchard is in the first place a review of what is at present known as to the action of bacterial secreta on micro-organisms and on animal organisms; and secondly, a record of the author's own views. It will be sufficient here to allude to the various theories of immunity, which in this book are discussed at length. According to the author, acquired immunity depends on two factors:—first, an increased germicidal influence of the animal fluids; and secondly, an increased inclination of the cells to act as phagocytes. If, therefore, the leucocytes acquire an increased tolerance for the bacterial virus, and at the same time the germicidal power of the animal fluids is augmented, the organism may then be said to have obtained an acquired immunity for the disease in question.

Fraenkel's Bacteriology.‡—The third edition of Fraenkel's Outlines of Bacteriology has just appeared. As far as the lines on which it was originally constructed are concerned, it remains the same, differing from its predecessors chiefly in the additional facts which it records. Thus, several kinds of bacteria are described in the special part for the first time, the position of some is altered, e. g. cholera bacilli are now ignored in favour of the term vibrio. This part is further expanded by the additional space given to the bacteriological examination of air and water.

* 'Diagnostica dei batteri delle acque con una guida alle ricerche batteriologiche e microscopiche,' Torino, 1890, 8vo, 121 pp. See Centralbl. f. Bakteriol. u. Parasitenk., viii. (1890) pp. 594–5.

† 'Actions des produits sécrétés par les microbes pathogènes,' Paris, 1890. See Centralbl. f. Bakteriol. u. Parasitenk., viii. (1890) pp. 433–5.

‡ C. Fraenkel, 'Grundriss der Bakterienkunde,' 3rd ed., 1890, 515 pp. See Centralbl. f. Bakteriol. u. Parasitenk., viii. (1890) p. 621.

Bacteriology for Agriculturists.*—With regard to C. Kramer's Bacteriology, it will be sufficient to say that it is specially intended for the use of those engaged in agricultural pursuits. Only the first part has appeared, and this deals first with the morphology and biology of bacteria, and also with the methods of examining and cultivating them. The remainder deals with the bacteria in the soil, the changes produced in soil by bacteria, the decomposition of manure and other organic substances, the symbiosis of Leguminosæ and bacteria, and finally with the diseases induced by bacteria in plants and animals.

Baumgarten's Annual Report on Pathogenic Micro-organisms, including Bacteria, Fungi, and Protozoa.†—The second half of Baumgarten's report on pathogenic microbes for the year 1888 has recently appeared. Beyond stating this fact it is scarcely necessary to say more than that it deals with the literature of the subject in the usual exhaustive manner, and will be found indispensable by those working at pathogenic microbes.

Danziger.—**Tuberculose bei einem Hahn.** (Tuberculosis in a Cock.)
Allgem. Med. Centralzeitung, 1889, No. 88.

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Korrespondenzbl. f. Schweiz. Aerzte, 1890, No. 19, pp. 612–24.

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Günther, C.—**Einführung in das Studium der Bakteriologie mit besonderer Berücksichtigung der mikroskopischen Technik.** (Introduction to the study of Bacteriology, with special reference to Microscopical Technique.)
Leipzig, 1890, large 8vo, ix. and 244 pp.

Hunt, E. M.—**Micro-organisms and Leucocytes: our present status as to each.**
Med. Record, XI. (1890) No. 14, pp. 376–8.

Krueger, R.—**Beitrag zum Vorkommen pyogener Kokken in der Milch.** (On the presence of *Micrococcus pyogenes* in Milk.)
Centralbl. f. Bakteriol. u. Parasitenk., VII. p. 590.

Kruse, W.—**Ueber Blutparasiten.** (The Parasites of the Blood.)
Virchow's Archiv, CXX. p. 541; first communication.

Laurent, E.—**Etude sur la variabilité du bacille rouge de Kiel.** (Study on the Variability of the Red Bacillus of Kiel.)
Annal. de l'Institut Pasteur, 1890, pp. 465–83.

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Fortschr. d. Med., 1890, pp. 665–72.

Marmorek.—**Bakteriologischer Beitrag zur Kenntniss der Influenza.** (Contribution to the Bacteriology of Influenza.)
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Ruffer, M. A.—**Notes on the Destruction of Micro-organisms by Amœboid Cells.**
Brit. Med. Journ., 1890, No. 1548, pp. 491–3.

Schrön, v.—**Zur Genese der Mikroorganismen.** (The Development of Micro-organisms.) *Allgem. Wiener Medic. Wochenschr.*, 1890, pp. 435–6.

Stern, R.—**Ueber die Wirkung des menschlichen Blutes und anderer Körperflüssigkeiten auf pathogene Mikro-organismen.** (On the Action of Human Blood and other body-fluids on Pathogenic Micro-organisms.)
Zeitschr. f. Klin. Med., XVIII. (1890) pp. 46–71.

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* Wien, 1890, 8vo, 171 pp. See Centralbl. f. Bakteriol. u. Parasitenk., viii. (1890) pp. 462–5.

† 'Jahresbericht über die Fortschritte in der Lehre von den Pathogenen Mikroorganismen, umfassend Bakterien, Pilze und Protozoen,' Braunschweig, 1890, Jahrg. iv. (1888) 2te Hälfte, pp. 257–587.

MICROSCOPY.

a. Instruments, Accessories, &c.*

(1) Stands.

Report of the Committee of the American Society of Microscopists on Uniformity of Tube-length.†—The following Report has been issued by the American Society of Microscopists :—"Believing in the desirability of a uniform tube-length we unanimously recommend :—

(1) That the parts of the Microscope included in the tube-length should be the same by all opticians, and that the parts included should be those between the upper end of the tube where the ocular is inserted and the lower end of the tube where the objective is inserted.

(2) That the actual extent of tube-length as defined in section 1—Be, for the short or Continental tube, 160 mm. or 6·3 in., and 8½ in. or 216 mm. for the long tube, and that the draw-tube of the Microscope possess two special marks indicating these standard lengths.

(3) That oculars be made par-focal, and that the par-focal plane be coincident with that of the upper end of the tube.

(4) That the mounting of all objectives of 1/4 in. and shorter focus should be such as to bring the optical centre of the objective 1½ in. below the shoulder; and that all objectives be marked with the tube-length for which they are corrected.

(5) That non-adjustable objectives be corrected for cover-glass from 15/100 to 20/100 mm. (1/130 to 1/170 in.) in thickness.

These recommendations give a distance of 10 in. (254 mm.) between the par-focal plane of the ocular and the optical centre of the objective for the long tube, and are essentially in accord with the actual practice of opticians.

At the request of the committee, a joint conference was held with the opticians belonging to the society and present at the meeting. They expressed their belief in the entire practicability of the above recommendations, and a willingness to adopt them.—Signed, Simon H. Gage, A. Clifford Mercer, Prof. Barr."

Swift and Son's Improved Student's Microscope.—At the October meeting of the Society, Mr. G. C. Karop exhibited and described this instrument (fig. 1), which he said had been brought out by Messrs. Swift at his suggestion. The aim was to produce a Student's Microscope of a superior design, with which high-class optical appliances could be used.

The body-tube is made to take the full-size eye-pieces in general use, and short enough to work with objectives adjusted to the Continental tube-length.

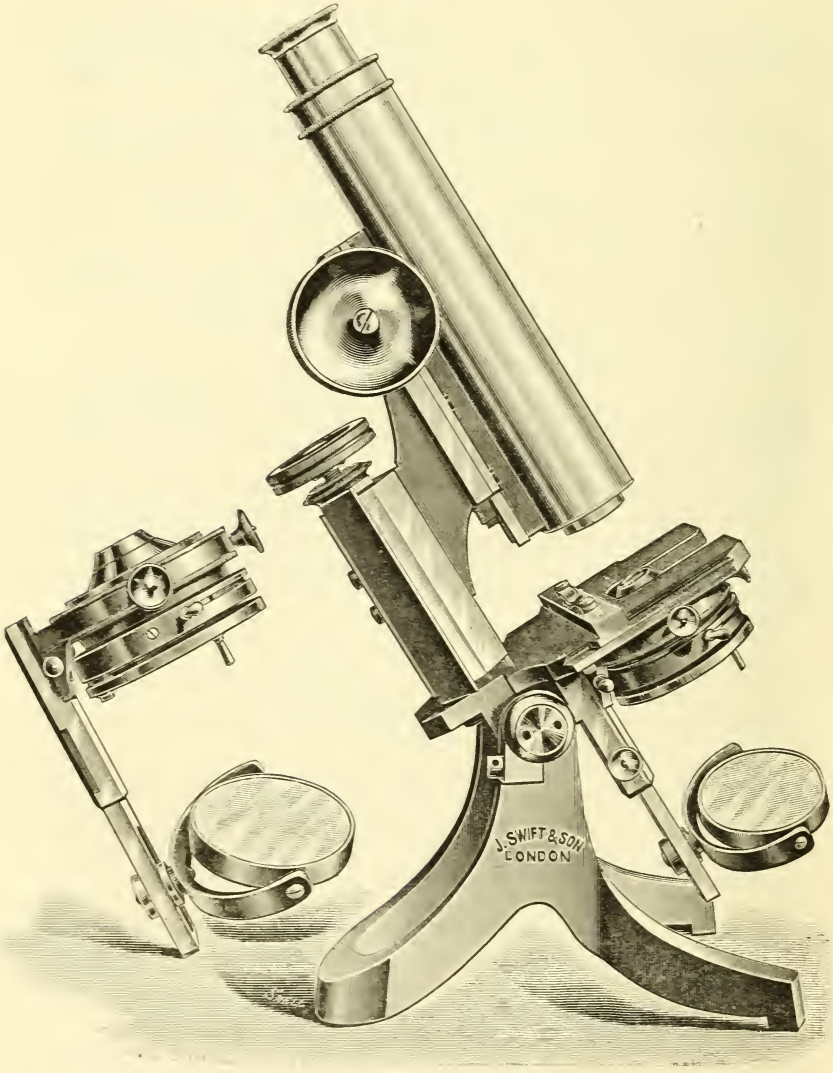
A draw-tube lengthens to the English standard of 10 in. The bearing carrying the body is made longer than usual in students' instruments, so as to give greater firmness with low-power objectives. The fine-adjustment was that known as Campbell's Differential Screw

* This subdivision contains (1) Stands; (2) Eye-pieces and Objectives; (3) Illuminating and other Apparatus; (4) Photomicrography; (5) Microscopical Optics and Manipulation; (6) Miscellaneous.

† Microscope, x. (1890) p. 297.

system, and is arranged for very delicate focusing. Both the coarse and fine adjustments are provided with extra large milled heads to afford a firm grasp. The stage is of the Nelson horse-shoe shape, and

Fig. 1.



large enough to take culture-plates ; this form is adopted for lightness and for the facility it gives in feeling the working distance of the objective. Instead of the usual spring clips, a sliding frame is provided

with sprung guides moving in grooves at the sides of the stage; small clips are applied for use in the horizontal position. The Mayall mechanical stage can be applied if required. The sliding-bar carrying the substage is specially well fitted so that a condenser of fairly large aperture may be focused, and a clamping screw fixes it in position. The substage has mechanical centering movements, and an iris-diaphragm. The mirror is removable in case it may be desired to work with direct light from the lamp.

We are requested by Messrs. Swift to note that at a small additional cost they can apply a rack-and-pinion instead of the sliding movement to the substage.

Mason's Improvements in Oxy-hydrogen Microscopes.*—Mr. R. G. Mason, of 69, Clapham Park Road, Clapham, S.W., has introduced the above form of lantern and table Microscope, a patent for which has been applied for. Until the present time the lantern Microscope has been a distinct instrument from the table form of stand. By the union of the above parts an instrument is obtained that, when not in use for

Fig. 2.

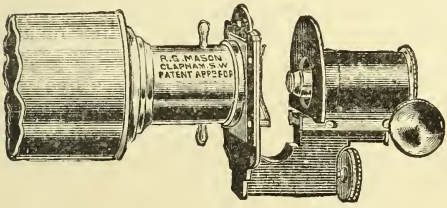
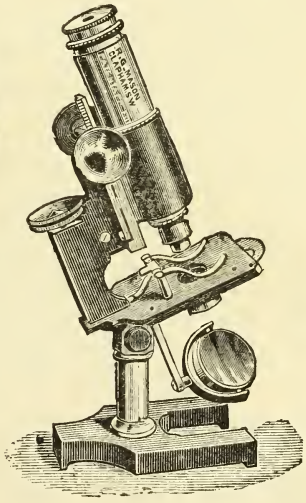


Fig. 3.



screen projections, can be easily altered, as shown by fig. 3. No unscrewing is required, and there are no loose parts. Fig. 2 shows the instrument as used on the lantern. It is very convenient for the science teacher or general lecturer, as a demonstration may be made to either a small or large audience with equal facility. The lower part, which carries the joint for inclining the instrument at any angle, is fitted with concave and flat mirrors on swinging arm, also with the universal size substage fitting tube for apparatus. The body and draw, which fits into the upper part, is of large diameter, and is screwed with the Society's size screw, thus enabling any ordinary microscopic objective to be used with it. It is fitted with a first-class rack, and also screw fine motion working steadily under high powers. This fine motion is especially useful in photo-micrography. The stage being of the usual form, both object and objective are in view, and easily manipulated while in use, thus doing away with an objection that is often present in the older forms of lantern

* Engl. Mech., lii. (1890) pp. 306-7.

Microscope. A further improvement is a spring clip, enabling the object to be easily changed without scratching the labels, &c., its construction admitting of either a deep zoophyte trough or the thinnest 3 × 1 slip being held gently but firmly. The parts are supplied separately, so that any one needing only the lantern arrangement can add the other at any future time.

(3) Illuminating and other Apparatus.

The Substage Condenser: its History, Construction, and Management; and its effect theoretically considered.*—Mr. E. M. Nelson remarks—"The substage condenser is nearly as old as the compound Microscope itself. The first microscopical objects were opaque, and in very early times a lens was employed to condense light upon them. It was an easy step to place the lens below the stage when transparent objects were examined.

Coming to more modern times we find that the culminating type of non-achromatic Microscope was fitted with a substage condenser, but it had a very brief existence, not being able to hold its own against the recently introduced achromatic. Had the invention of achromatism been delayed, it would, I have no doubt, have had enormous popularity for those times. I allude to the Wollaston doublet with its substage condensing lens, particularly that form designed by Mr. Valentine and made by Andrew Ross in 1831.

Before proceeding we must remember by whom the Microscope was used at that time. As far as this country was concerned, it was merely looked upon as a philosophical toy. It was principally to be found in the hands of a few dilettanti; science of every kind was tabooed, the Microscope being placed at the lowest end of the scale.

Now, the Microscope of the dilettanti is usually a perfect instrument of its kind, fully supplied with apparatus, the greater part of which is absolutely useless, but among this apparatus there would always have been a substage condenser. One of the principal things the dilettanti have done for us is the keeping up through early achromatic days of the continuity of the condenser.

On the Continent, where science held a much more important place, the real value of the Microscope was better understood, and it at once took an important place in the medical schools. But the increase of light due to the more perfect concentration of rays by achromatism enabled objects to be sufficiently illuminated by the concave mirror to meet their purposes. Therefore, we find that on the Continent the Microscope had no condenser. Of course there were isolated exceptions, Amici's for example; but I think we may safely say that for every Hartnack made with a substage condenser there were upwards of one thousand made without.

England followed the Continental lead, and now the "foolish philosophical toy" has entirely displaced in our medical schools the dog-Latin text-book with its *ordo verborum*. But the kind of Microscope adopted was not that of the English dilettanti, but the condenserless Continental. It may be said that the Microscope for forty years—that

* Journ. Quek. Micr. Club, iv. (1890) pp. 116–36. For the use of the accompanying plate we are indebted to the kindness of Mr. Nelson and the Quekett Microscopical Club.

is, from the time it was established in the schools in, say, 1840 to 1880, has been without a condenser. Not only did those who used the condenserless Microscope consider the condenser an unnecessary appendage, but they looked down upon it and regarded it in the same category as one of the multitudinous appliances that are packed in such a wonderful manner in the apparatus cabinet of a Microscope made for exhibition.

In 1880 a change came from two separate causes—first, the rise of bacteriology; secondly, the introduction of a cheap chromatic condenser by Abbe in 1873.

Taken by itself, the introduction of the Abbe condenser had not much effect, but as Zeiss's Microscopes had for some time been displacing the older forms, and when the study of bacteriology arose, oil-immersion objectives of greater aperture than the old dry objectives (especially those of the histological series) were used, illumination by the mirror was soon discovered to be inefficient, so a condenser became a necessity. The cheap Abbe condenser was the exact thing to meet the case.

Since 1880 the percentage of educational Microscopes, medical or otherwise, without condensers, has been daily on the decrease. There has not been, during the past history of the Microscope, a more marked change of opinion with regard to any apparatus than that which has taken place in connection with the condenser.

It is worthy of notice that this change of opinion has been so complete that those who formerly condemned all condensers now look upon the Abbe chromatic (probably the worst condenser ever constructed) as a distinct advance in microscopy!

It must be remembered that the end of an educational Microscope is not to discover anything new, but to follow the figures given in the text-books, and when the text-books kept on the level of the larger objects any tube with a piece of glass at either end was sufficient for the purpose; but as the text-books improved and went deeper into the structure of things it was necessary that the student's Microscope should be of a better description. For example, as long as the text-books wrote about and figured the spiral vessels in the blowfly's tongue, so long the student did not require a Microscope capable of showing the cut suctorial tubes.

As I mentioned above, the "few," principally dilettanti, had all along used a condenser. I myself had not long entered the microscopical world as a member of the latter class before I found out that a condenser was a necessity. Now, as I have used all the kinds of condensers that have been introduced, I will give my own history in connection with them, as it will be the history of the condenser.

My first condenser was a Gillett; this was in power a 1/4, and it had 80° of aperture. The Gillett is practically the first achromatic condenser really constructed as such; before that time objectives were used, the rule being to select that objective which was next lower in power to the objective on the nose-piece. The manner of centering—for centering was duly insisted upon even in those early times—was so funny that I must recall it. Vertical movement was performed by the substage, but the horizontal movement by the Microscope body!

The Gillett was an elaborate instrument; it was supplied with a

correctional lens adjustment for the aberrations arising from the thickness of the slip. I have a distinct affection for the Gillett, for it was with that condenser I taught myself what a critical image was. In 1874, however, I purchased a P. and L. new formula water-imm. 1/8 of N.A. 1·21. These and similar lenses by Tolles far surpassed anything at that day. There was a greater difference between these lenses and their cotemporaries than there was between the homogeneous immersion and these same lenses four years later. I can only liken the improvement which those lenses ushered in to that which has lately been achieved by Abbe's apochromatics. It was the possession of this lens (P. and L. new formula 1/8) that first made the inadequacy of the Gillett apparent to me. This led me to get P. and L. dry achromatic condenser, which I still have. This condenser was designed by Powell in 1857; it is a 1/5 in power, and ·99 N.A. in aperture, and is the best ever introduced.

I must now say a word or two on low power condensers. Low power objectives had, somehow or other, been left out in the cold, no condenser having been provided for them. A sop, in the shape of a paraboloid or spot lens, was every now and then thrown to them, but, as far as I know, the first low power condenser we hear of is Webster's, in 1860.

The next was Abbe's chromatic,* 1873; Swift's achromatic, 1874; Abbe's achromatic, 1888, and Powell's new one, last year.

On the Continent the Microscope may be said to have remained condenserless until the rise of bacteriology compelled the general adoption of the Abbe in 1880. I will now give a parallel table showing the data and form of various condensers that have been introduced since the days of achromatism:—

England.	Continent.
1826. Single lens, Tulley.	1827. Single lens, Amici.
1840. Objective.	1833. Chromatic, Chevalier.
1850. Gillett, three pairs, N.A. ·65.	1839. Objective, Dujardin
1857. Powell, two pairs and single, anterior middle concave, N.A. ·99.	
1865. Webster, single front, achromatic back.	
1874. Swift, two pairs and single front, N.A. ·9.	1873. Abbe, chromatic, N.A. 1·2, hemispherical front, crossed back.
1878. P. and L. achromatic, improved anterior middle plane, ·99 N.A.	(? date) Another form, N.A. 1·4, single front, Herschelian doublet back.
1881. P. and L. oil chromatic, same as Abbe only higher power, N.A. 1·3. Ditto, truncated, N.A. 1·4.	
1887. P. and L. oil achromatic, N.A. 1·4, three pairs and single front.	1888. Abbe achromatic, two pairs and a single front, N.A. 1·0.
1889. P. and L. low power achromatic, N.A. 1·0, one pair and two singles.	

* Abbe's chromatic stopped down makes a far better low power condenser than it does a high power, as the stop reduces the abnormal amount of spherical aberration.

This table shows that here, at least, there was an activity with regard to the condenser that was totally absent abroad. It must, moreover, be remembered that the list gives only types of condensers: Ross, for instance, made improvements on the Gillett, and Smith and Beck made numerous forms of condensers which have not been mentioned, simply because they were not typical. Messrs. Crouch and Collins made numerous condensers, mostly after the Webster type. So also, on the other side, Nachet and Hartnack fitted object-glasses as condensers, only to a much more limited extent. My impression is that, if statistical tables were available, it would be found that up to 1880 there were more condensers turned out by any one well-known English maker than by all the Continental firms put together.

We now come to the use of the condenser, and the first question that arises is with regard to the nature of the source of light: Is daylight or lamplight to be used?

I find with low and medium powers, the condenser being centered to the optic axis, the plane mirror used, and a window-bar focused on the object, that daylight gives very good results, especially if a brightly illuminated white cloud is the illuminating source; but when the white cloud has blown across the field, leaving only blue sky, the illumination becomes poor. My complaint against daylight illumination for low power work is that I believe it not only to be always changing, but also very injurious to the eyesight. When I began Microscopic work the white cloud was everything, but on account of the above-mentioned drawbacks I adopted artificial illumination. The most extraordinary ideas prevailed respecting artificial illumination. The history is as follows:—Brewster wrote a treatise on the Microscope in 1837, and in it explained his method of illumination. He was very keen on monochromatic illumination; this he obtained from some chemical substances flaming in a saucer, without any wick or chimney; light from this was parallelized by a bull's-eye formed by a Herschelian doublet, and this brought to a focus by another exactly similar lens. He is very particular to enforce that the image of a diaphragm placed between the source of illumination and the bull's-eye should be focused on the object. This was in preachromatic days, and the kind of Microscope he experimented upon was the simple Microscope, the lenses being jewel singles, doublets, triplets, Coddingtons, which last were his own invention, &c.

With such a source of illumination, unless his object had been in rays considerably condensed, he would not have seen anything at all. Be that as it may, the fact is that the rule of having the source of light in focus has been handed down by the text-books all along, only with this curious proviso, viz. that each author had his own particular directions for disregarding the rule.

Taking Andrew Ross first, whose directions are considered so admirable that Quekett says he will quote them at length, we find that after he has given instructions with regard to centering, he says that delicate objects are best seen by racking the condenser within, and objects having some little thickness without the focus. Further on he says that slight obliquity of the illumination subdues the glare attendant upon perfectly central and full illumination by lamplight; he then goes on to say how this slight obliquity may be secured. The above words

form the keynote for artificial illumination in every subsequent text-book. They are repeated by Carpenter, who, after giving directions as to centering and focusing the image of the lamp-flame on the object, says that "the direction of the mirror should then be sufficiently changed to displace the image and to substitute for it the clearest light that can be obtained." Further, he recommends that while with daylight the condenser should be used in focus, with lamplight it should be somewhat racked down. From this I gather that Dr. Carpenter's best artificial illumination is oblique light out of focus. Of course the actual fact is that daylight focus is not nearly so important as lamplight. In illustration of another kind of mistake, as late as ten years ago it was recommended that the diaphragm be placed above the condenser as giving a better result than when placed below.

Of course the optical effect is precisely the same, the only thing is that the diaphragm below the condenser is much more readily manipulated and is much more likely to be accurate in centering, unless the one above be of the cap form. To change a cap diaphragm necessitates either the removal of the slide or the condenser, and all for no purpose. The next idea was worse, viz. the calotte diaphragm. This being fixed to the stage and not to the substage, gave as often as not excentric pencils. Whatever diaphragm is used it obviously must be centered to the condenser and must move with it, otherwise it will be put out of centre during the operation of centering the condenser to the optic axis of the objective.

Further, the calotte diaphragm is useless for ordinary illumination without a condenser, as the apex is not the proper place to cut the illuminating cone. The proper place, therefore, for a diaphragm, when no condenser is used, is some distance from the object, and when a condenser is used, is at the back of the combination. Further, when a diaphragm is above the condenser the apertures become almost microscopic in size, and a very small difference between them will make a considerable difference in their effect; but when they are placed behind the combination they may be larger, and it becomes more easy to graduate them in accordance to any desired effect.

Again, it is a fallacy to suppose that a Kelner eye-piece is superior to a condenser as an illuminator for high powers.

A Kelner eye-piece, if a C, is only 1 in. in power, and has a small angular aperture somewhat less than 45°, therefore it cannot possibly give a cone at all comparable with that from a most elementary condenser. It might be used as a substage condenser for low powers, but from its small aperture it would hardly give a good dark-ground illumination for a 1-in. objective.

With regard to low power condensers, the Webster (as designed by Webster) is the proper form. There are many so-called Webster condensers in existence which are on a totally wrong principle. The right kind of Webster has a single front lens and a back lens composed of a plano-concave flint and a crossed convex crown, the cemented surfaces having a deep curve to overcorrect the lens. The other kind, which is quite wrong, has an achromatized front and a single back; it is merely done for cheapness, as small achromatic pairs are not so expensive as large ones, and the back lens of a condenser is always larger than the front.

Another mistake is that direct light is more critical than indirect, which means, in other words, that illumination without a mirror is more critical than illumination with a mirror. Presupposing the same conditions, viz. the same condenser with the same stop, the centering and focus being precise, the optical conditions must be identical and the result the same. The ground is entirely cut away from the one only thing which could possibly affect the result—I allude to the loss of light by reflection at the mirror, by the fact that you have, with merely a 1/2-in. paraffin wick, more light than you know what to do with. So much is this the case that in my own practice I am in the habit of using a double cobalt pot-glass screen to reduce the intensity.

I am aware that direct illumination is a most convenient and time-saving method, especially when the instrument is well tucked up on its trunnions, but that it makes any perceptible difference in the criticalness of the image I am not prepared to admit.

With regard to mirrors, a good deal of misapprehension exists. It matters little whether the mirror be dusty or scratched, or the silver in bad condition; the only effect these will have will be to cause a little less light to fall on the back lens of the condenser, a matter supremely unimportant. An old scratched dull mirror will yield as critical an image as the finest worked up silver on glass Newtonian flat.

The three things that are of paramount importance are the direction of the light, the angle of the cone, and the spherical aberration of the condenser. Mirrors which yield secondary reflections are to be avoided, but if they can be turned round in their cells the secondary images can be easily eliminated.

Having touched upon the errors in the use of the substage condenser, let me say a few words with a view of clearing up some strange notions that are held with regard to its office. The original prevailing idea with regard to the office of a substage condenser was, I believe, in the first instance, that of a contrivance by which more light could be secured; afterwards it became chiefly important as an oblique illuminator; but its true function as that of a cone-producer was not generally recognized. As this view of mine will probably be met by the criticism that in the text-books, both ancient and modern, we read "that the condenser must be accurately focused," that the use of the diaphragm is for the purpose of contracting the cone of illumination" (many similar passages might be quoted), I nevertheless contend that there are other passages which conclusively prove that the writers were ignorant of the true function of the condenser.

The following is an example :—"If the cone of rays should come to a focus in the object, the field is not unlikely to be crossed (in the daytime) by the images of window-bars or chimneys, or (at night) the form of the lamp-flame may be distinguished upon it; the former must be got rid of by a slight change in the inclination of the mirror; and if the latter cannot be dissipated in the same way, the lamp should be brought a little nearer."

This passage proves that the end-all and be-all in the writer's mind was the agreeableness of the illumination; when the glare of the lamp-flame becomes unpleasant, the cone may go to the wall.

If the importance of the cone had been paramount in the mind of

the writer. he would have certainly suggested the obvious method of softening down the intensity of the flame-image by interposing coloured screens. Taking the whole tenor of the passage, there cannot be the least doubt that the ends sought for were suitable intensity of light and equable illumination of field; the frequent mention of the word cone being more accidental than insisted on for the sake of the cone itself.

It is as a cone-producer wherein the efficacy of the condenser lies. If, as is implied in the text-books, it were only light-intensity which gave criticalness to the image, that could be secured by exchanging the light from the 1/2-in. paraffin wick for that from the electric arc, but such an exchange would cause no alteration in the character of the image so long as the aperture of the cone remained the same.

The real office of the substage condenser being a cone-producer, the first question that arises is, What ought to be the angle of the cone?

This is really the most important question that can be raised with regard to microscopical manipulation. To this I reply that a 3/4 cone is the perfection of illumination for the Microscope of the present day.* By this I mean that the cone from the condenser should be of such a size as to fill 3/4 of the back of the objective with light, thus N.A. 1·0 is a suitable illuminating cone for an objective of 1·4 N.A. (dark grounds are not at present under consideration). This opinion is in direct opposition to that of Prof. Abbe in his last paper on the subject in the December number of the R. M. S. Journal for 1889, where he says: —"The resulting image produced by means of a broad illuminating beam is always a mixture of a multitude of partial images, which are more or less different (and dissimilar to the object itself). There is not the least rational ground—nor any experimental proof—for the expectation that this mixture should come nearer to a strictly correct projection of the object (be less dissimilar to the latter) than that image which is projected by means of a narrow axial illuminating pencil." †

This paper I consider to be the most dangerous paper ever published, and unless a warning is sounded it will inevitably lead to erroneous manipulation, which is inseparably connected with erroneous interpretation of structure.

If you intend to carry out his views and use narrow-angled cones, you do not need a condenser at all—more than this, a condenser is absolutely injurious, because it affords you the possibility of using a large cone, which, according to Prof. Abbe, yields an image dissimilar to the object. If there is the slightest foundation for Prof. Abbe's conclusion, then a condenser is to be avoided, and when a mirror is used with low powers care must be exercised to cut the cone well down by the diaphragm.

In the opening sentence of the paper Prof. Abbe says, "The diffraction theory leads to the following conclusions in regard to the mode of illumination in question." We are, therefore, thrown back on the diffraction theory, for the discussion of which I must ask your kind

* Mr. Comber (R. M. S., May 21st, 1890) states that in practice he finds a 2/3 cone best for photomicrography. A 2/3 cone (photographically) is to a 3/4 cone (visually) as 10/12 is to 9/12. Mr. Comber's experience is therefore in accordance with this statement.

† R.M.S. Journal, 1889, Part 6, p. 723.

indulgence, as the only other avenue for such a purpose has been closed to those who do not accept Prof. Abbe's theory in its entirety.

The diffraction theory has been likened, as you are aware, to the theory of gravitation. Let us, therefore, compare them. The theory of gravitation may be said to rest on three points—viz. mathematical proof, physical law, and experimental proof;—moreover, it is not afraid of criticism.

The diffraction theory rests on no mathematical proof—in the main it accepts the physical law of diffraction; but on experiment it utterly breaks down, all criticism is stopped, and everything connected with it has to be treated in a diplomatic kind of way.

Both theories may be said to resemble an arch, being built up on theory and experiment, and held in equipoise by a keystone at the top. The diffraction arch, after being built up on theory and experiment, culminates with the calculation of the Eichorn intercostals as its keystone. The discovery of these intercostals on the *P. angulatum* (which has been likened to the discovery of the planet Neptune) was arrived at by "a mathematical student, who had never seen a diatom, and who worked the purely mathematical result of the interference of the six spectra."

In the same way the discovery of Neptune may be called *a* keystone of the gravitation theory. It would be incorrect in this connection to say *the* keystone, because the gravitation theory has many keystones, while the diffraction theory has only the one, viz. the Eichorn intercostals. If, for instance, one could prove that the planet Neptune had no objective reality, but was a mere optical ghost, the gravitation theory would be seriously compromised. If, this evening, I can prove that the Eichorn intercostals are ghosts, then I maintain that I have taken the only keystone from the diffraction theory arch, and the conclusions which Prof. Abbe has arrived at in consequence of that theory, with regard to illumination by means of the wide-angled cone, are fallacious.

Let me at this place state that I wish it to be distinctly understood that I am not, in this paper, attacking Prof. Abbe's brilliant discovery that the image in the Microscope is caused by the reunion of rays which have been scattered by diffraction, neither do I question what I venture to think is his far more brilliant experiment, which exhibits the duplication of structure, when the spectra of the second order are admitted, while those of the first are stopped out. I regard these facts as fundamental truths of microscopy. The thanks of all true microscopists are due to Prof. Abbe for giving them to us. It will be then asked, how can you disagree with that which you admit? The point is, that it is in the meaning of the word "diffraction image" that the difficulty lies. Let me explain. There are in reality three kinds of diffraction images, for which I will now substitute the following names, "true diffraction image," "true diffraction ghost," and "false diffraction ghost," in place of those I used in my previous paper.* Now I maintain that both Prof. Abbe and his exponents at the R.M.S. have fallen into the grievous error of not distinguishing between these

* Q.M.J., Ser. II., vol. iv., No. 25, p. 17, "true, true false, and false."

three images, viz. the true diffraction image, and the true and false diffraction ghosts. You will naturally ask, how do you distinguish between these three images? A true diffraction image goes in and out of focus like a daisy under a 4 in. In other words, a true diffraction image is one out of which it is impossible to make another image by focal adjustment. A diffraction ghost, on the other hand, is one which changes into other images on focal adjustment, a false diffraction ghost being an image which is dissimilar to the original, and a true diffraction ghost one in which it is fairly in accordance with the original.

A true diffraction image is produced by a large cone of illumination, except in those cases where the structure is so fine, in relation to the aperture of the objective, that the large cone does not cause the spectra to overlap one another and the dioptric beam.

True and false diffraction ghosts are produced by small cones, except in those cases where the structure is either so coarse that the spectra overlap, even with the small cone, or so fine that only spectra of the first order are taken up by the objective; in this latter case a false diffraction ghost becomes impossible. Taking the ghosts first, the reason why there is a change of image on alteration of focus may be seen on reference to plate II. fig. 3. Let O be an object having about 20,000 interference elements per inch, let DD be an infinitely thin dioptric beam in the optic axis, then S and M will be the spectra of the first order, and T and N those of the second. If the object be examined by an objective whose aperture is greater than the angle T O N, i. e. upwards of 100°, a diffraction ghost will be seen, because at the longer focus the spectra S and M will be united with D, and a representation similar to the true structure will be produced; but on shortening the focus the spectra T and N will be united with D, and a picture having double the fineness of the original structure will be seen. (You require no stop at the back of your objective to perform this experiment; the spherical aberration, which is always present, even in the best corrected lenses, will be sufficient to prevent the union of S and M with T and N. See Mr. Leroy's results on applying the Foucault test to Microscope objectives, R.M.S.J., 1890, p. 224: the spherical aberration varied from tenths of mm. to several mm.) It is therefore a diffraction ghost, because the image alters on focal adjustment; it is a true ghost at the upper focus and a false ghost at the lower focus.

Let us now see what takes place when a large cone is used. Let PP be an isolated pencil of such a cone, then HQ will be spectra of the first order, and R a spectrum of the second, and K one of the third order. These dotted lines are drawn at a little distance from the others for the sake of clearness, but they are supposed to be either coincident with or very near the others. Here we see at the upper focus that a spectrum of the second order R is combined with a dioptric beam P, and a first diffraction spectrum Q, and this takes place in addition to the combination of S and M with D mentioned above. Bringing in a diffraction spectrum of the second order will tend to improve the image. At the lower focus even now there will be a first diffraction spectrum H, combined with a third order spectrum K, together with the combination of H and N with D as above. This combination would give a confusion of images, so it comes to pass that images with

a wide angled cone at the lower focus are blotted out. To state the combinations more concisely at the upper focus, we have two first order spectra and a dioptric beam; and a first and second order spectrum and a dioptric beam.

At the lower focus you have two second order spectra and a dioptric beam; and two first orders and a third order.

It may be as well to explain to those not acquainted with optics, that these combinations are caused by the spectra T N and H R passing through the same zone of the objective. The union of a set of spectra such as S D M makes a certain kind of image, and the union of P Q R will make a very similar image, not absolutely similar, but so similar that it would be difficult to tell the difference between them. So it comes to pass that the superposition of a number of very similar images strengthens the picture and gives a resultant image very close to the original structure. But the image caused by the union of T D N is totally dissimilar to the original, and H Q K would also be very dissimilar and the superposition of a number of these can only make a stronger dissimilar picture, or if the pictures, which are superposed, differ widely from one another, then the superposition of them will produce a fog. By way of illustration, suppose I made a large number of photomicrographic lantern slides, using certain spectra, which gave an image closely resembling an original known structure, and suppose each lantern slide to be a picture, resulting from a different narrow dioptric beam, such as D and P in our diagram, and others lying between them, we should then have a number of lantern slides, all very similar to the original and consequently to one another. Now suppose we had a number of lanterns and projected these several images at once on the screen, the several images would combine to form a strong image closely resembling the original structure. If, however, we make other lantern slides, using spectra, such as T N, which double the original structure, and if these are projected on the screen in place of the others, we shall get a strong image of a structure altogether dissimilar to the original. But if we increase the number of our lanterns, and project the other images as well, we shall have a confused image on the screen, or fog. Another illustration may help to simplify the matter. Suppose it were possible in photographing a dog with an ordinary camera, by manipulations at the back of the objective, to obtain, either an image only very slightly dissimilar to the real dog (such as an image slightly out of focus), or with other manipulations to obtain a picture of a hayrick. If a number of these slightly dissimilar images of the dog were projected on the screen, we should still have the image of a dog, and one that we could readily recognize. But if we projected the images of the hayrick, we should not have the slightest idea that the original object was a dog, and further, if the images of the hayrick were projected at the same time as those of the dog, the result would be a confused mass of light in which it would be impossible to recognize any image. Whether any particular lantern slide turn out a dog or a hay-rick, depends on the physical union of various other oscillations, but whether the image of either the dog or hayrick be a strong one, or a mass of fog, depends on the mechanical combination of similar or dissimilar images.

We must now return to the Eichorn intercostals; the history regarding these is as follows:—

The six spectra of the first order of *P. angulatum* (fig. 1) were set to a student who had never seen a diatom, and he calculated the presence of an intercostal. These intercostals were afterwards seen by Mr. Stephenson, and the student's discovery was likened to that of Neptune. There is a double error here. The first is that the intercostal is a function of the spectra of the second order, and can neither be calculated, originated, nor seen by those of the first order.

Secondly, the intercostal is not a true diffraction image, but is a false diffraction ghost, and is caused by the reunion of the spectra of the second order, and the exclusion of the first order.

The very data given to the student have to be excluded before an intercostal can appear or be calculated!

The error in connection with the exhibition of the intercostals of the *P. angulatum* is that no sufficient checks were imposed to render it absolutely certain that no spectra of the second order were present at the time the intercostals were seen. The intercostals have also been accounted for by a fallacious geometrical picture. Thus, the six spectra (fig. 1) account for three sets of lines ruled at 60° to each other. Now, as I pointed out in the 'English Mechanic,' vol. xliii., No. 1108, p. 337, two very different pictures are produced according to whether the third line be ruled through the apices of the rhombs (fig. 4) or not. It is for those who uphold the truth of the intercostals to show which spectrum or what arrangement of the six spectra determines that the third line does not pass through the apices of the rhombs (fig. 6). The contrary is really the fact, viz. that if there is any truth at all in the diffraction theory, then with a spectral arrangement as set to the mathematical student the third line must pass through the apices of the rhombs (fig. 5). Figs. 4, 5, and 6 show the rhombs and the formation of the two kinds of pictures. In passing, it is as well to note that objectives being for the most part spherically undercorrected, generally show the intercostals at the lower focus. In other words, you have to lower your objective in order to obtain the reunion of the spectra of the second order by means of the outer zone of the objective. Intercostals are due to illumination by means of a narrow cone, which allows and aids zonal differences to operate on the spectra, uniting those of the second order, whilst excluding those of the first.

Illumination by a large cone neutralizes the effect of these zonal differences, and intercostals disappear.

I have given much attention to diffraction ghosts, and have made several photographs of them for your inspection. Instead of confining my investigations to *P. angulatum*, as has been usually done, I thought it better to select very coarse structures, concerning the true appearance of which all microscopists are entirely agreed. In the first instance, I experimented with the coarse hexagonal structure of a *Triceratium*, which measured 1/3600 in. A photograph × 387 taken with a large cone I will now project (fig. 7). The illuminating cone was now cut down by closing the iris diaphragm, and the aperture of the objective stopped down until the spectra at the back of the objective appeared as in fig. 2. The next photograph (fig. 8) shows the image due to those

spectra; this shows the intercostals, and is what I term a false diffraction ghost. You will observe that the objective has been placed at a lower focus. If the same, i. e. the upper focus, had been used, then a picture similar to the true image taken with the large cone would be seen, except that the walls of the hexagons would be considerably thicker, and in the centre of each areolation there would be a dark spot.

If the illuminating cone be enlarged to a 3/4 cone the image will closely resemble the critical image (fig. 7) already shown, and moreover will be a true diffraction image, because it will go in and out of focus as a daisy under a 4-in. In examining the various images presented by a hexagonal grating in focal alteration, when a small cone of illumination is used, I found that these false diffraction ghosts followed a certain sequence, and might be grouped in three classes, which I term degrees. The false diffraction ghost of the first degree requires spectra of the second order (fig. 2), for its production. It is the Eichorn intercostal image.

The next experiment was performed with the narrow cone as before, but with the aperture of the objective reduced so that the second order of spectra (fig. 1), were cut out; according to my theory no intercostals should now be visible; on taking the photograph, however, a trace of them could be distinguished (fig. 9). This is such an interesting result that I have printed the negative. The fact was that I had cut out the second order spectra visually but not photographically. On further cutting down the aperture quite up to the end of the spectra of the first order, no intercostals could either be seen or photographed (fig. 10).

This is an additional proof that the intercostal image is a function of the spectra of the second order. Further, if an intercostal on *P. angulatum* is resolvable by means of spectra of the first order, which diverge about ·5 N.A. from the central dioptric beam, as affirmed by Eichorn, Abbe, and the anonymous writer of the article on microscopic vision in the R. M. S. Journal,* then the theoretical limit tables at the back of the Journal had better be torn up. The intercostals would count about 95,000 per in., and according to those tables they would cause the spectra of the first order to diverge about ·99 N.A. from the dioptric beam. So it would require an aperture of nearly 2·0 N.A. to grasp all the six. Therefore all these years the tables at the back of the R. M. S. Journal, and the anonymous article on microscopic vision, which is a condensed summary of all their and Prof. Abbe's teaching on the subject, are, as I have often pointed out, contradictory. This last experiment on the *Triceratium* with only the spectra of the first order admitted, shows that on focal alteration only a change from positive to negative diffraction images takes place, i. e. black to white dots; in other words, a black hexagon with a white centre changes to a white hexagon with a black centre and *vice versa*. The word hexagon is here incorrect; the pattern strictly speaking under these conditions is black or white circular dots arranged in a quincunx form. This experiment is most important, because it shows that when a small cone of illumination is used a more truthful image is secured by

* R.M.S.J., Ser. 2, vol. i. pp. 354.

reducing the aperture of your objective until all spectra are cut out, except those of the first order. The reasoning is as follows: With a small cone and an aperture sufficient to take in many orders of spectra on focal alteration, you obtain a series of changing images similar to those seen in a kaleidoscope. Without *à priori* conclusions you do not know your focus, consequently you cannot select the true diffraction ghosts from among the false diffraction ghosts.

But the moment the aperture of the lens is contracted so that only the spectra of the first order are admitted, one image and one image only is possible. This image is certainly not a very good image of the structure, nevertheless it cannot be very dissimilar.

In the case before us, instead of getting well-defined hexagons like those of a bee's honeycomb, we have in place of them circular bright spots, spaced correctly and in arrangement precisely similar to the original.

But it may be urged that all this only applies to diatom work, and has nothing whatever to do with ordinary microscopical objects. If you will pardon me for a moment I will endeavour to prove to you that it is of the highest importance with regard to almost every microscopical object, But first let me draw your attention, before leaving the *Triceratium*, to a false diffraction ghost of the second degree (fig. 11). This picture is only possible when four orders of spectra are admitted. Here you will notice that each bar of the hexagon is broken up into three dots, and six spots with a central one are imaged in each areolation. This is a difficult one to photograph on account of the great brightness of the areolations, which accounts for the images in those parts being weak. To show that this is a subject not at all confined to diatomic structures, the next experiments will be performed on the eye of a fly.

The spectra arising from this structure are identical with those from similar diatomic structures, only they are not so widely spread out, the intervals being 1/800 in. This proves that diffraction does not begin at 1/2500 in. I will first project the critical image (fig. 12) taken with a 3 4 cone × 165. The illuminating cone was now reduced, and the spectra, as in the next picture, allowed to pass into the objective (fig. 13). We now get the Eichorn intercostals. This shows that the diffraction theory has just as important a bearing in connection with a common entomological object as with a diatom. The next picture (fig. 14) was taken with a large cone, but the aperture of the lens was reduced so that it should bear the same proportion to the eye of a fly as an oil-imm. of 1·4 N.A. does to the *P. angulatum*. Here you will notice that the hexagon runs into a kind of square shape. A similar appearance can be obtained with a *P. angulatum*.

The structure of the eye of the fly being very coarse it is possible to pick up the whole of the diffracted fan; this, as seen at the back of the objective, is in itself such a beautiful object that I have endeavoured to produce it, but as yet without success. It is a beautiful star with hyperbolic edges, and is, as far as I am aware, unknown, nor figured anywhere. If this whole diffraction fan be admitted to the objective, then we get a false diffraction ghost of the third degree (fig. 15), and this is the last and most complicated ghost you can have. The founda-

tion of the picture is composed of three lines drawn at 60° to one another, the third line passing through the apices of the rhombs. I will next project a false diffraction ghost of *P. formosum*, showing intercostal dots (fig. 16). These were produced in precisely the same manner as the others. The focus, you will notice, is only slightly within the true focus. The greater the aperture of the objective used the less out of focus the object requires to be in order to produce the intercostals. Now I have shown you the three degrees of diffraction ghosts; these are all produced, and can only be produced by the small cone. It cannot be wondered that Prof. Abbe and his exponents say that "whether for example, *P. angulatum* possesses two or three sets of striæ, whether striation exists at all, whether the visible delineation is caused by isolated prominences, or depressions, &c., no Microscope, however perfect, no amplification, however magnified, can inform us."*

Again, we read "that every attempt to discover the structure of finely organized objects – as, for instance, diatom-valves— by the mere observation of their microscopic images, must be characterized as wholly mistaken." And again, "The interference images of minute structure, however, stand in no direct relation to the nature of the object, so that the visible indications of structure in a microscopical image are not always or necessarily conformable to the actual nature of the object examined."

The explanation of all this is that Prof. Abbe takes cognizance of one kind of image, and that one a diffraction ghost, and it is perfectly true that so long as you are dealing with diffraction ghosts you cannot, for certain, determine the nature of the structure you are observing.

At different foci when a small cone is used there are different images, and without *à priori* knowledge it is impossible to determine the correct focus, and consequently the true diffraction ghost. Now it is the function of the condenser to put an end to all these difficulties; it enables you to illuminate by means of a wide-angled cone, and then you have a true image at one definite focus, and at any other focus there is no image at all to confuse you.

Of course it must be understood that when the structure is very fine, and the spectra are diffracted through great angles, your widest-angled cone really becomes a narrow one in relation to that structure; and then you are obliged to make the best you can with diffraction ghosts. But there is, on that account, not the least reason why, for all coarser structures, you should not have a true diffraction image by means of a large cone instead of either a true or false diffraction ghost by a small cone.

Eventually our diffraction ghosts with very fine structures and wide-angled cones may through increase in the apertures of our objectives and improvements in our condensers, be changed to true diffraction images.

Prof. Abbe's last paper takes account only of small differences between very similar images, and ignores altogether the enormous differences due to the union of different orders of spectra and the exclusion of others. He is in fact straining at the gnat and swallowing the camel. In his paper he disregards the possibility of getting (to

* M.M.J., xiv. (1875) p. 220.

return to our former simile) a picture of a hayrick instead of a dog, while he insists that a small cone is preferable to a large one lest the dog appear foggy. To which I reply that a foggy dog is preferable to a hayrick, however sharp.

When the illuminating cone is enlarged so that it fills about 3/4 of the back of the objective, one image, and one image only, can be produced, which, as I have said, goes in and out of focus as a daisy under a 4-in. There can be now no doubling of the structure, and no multiple images are produced. Spherical aberration in the lens merely veils the image under an appearance of fog or mist. The clearness and distinctness of the image may be marred by its means, but the image cannot be altered in form.

I have only one more point to bring to your kind notice, and that is the statement that the wide-angled cone, by means of the superposision of dissimilar images, obliterates uncoloured histological tissues.*

The truth regarding this is that the wide-angled cone gives you a faithful representation of uncoloured histological tissues (very likely not the preconceived images regarding them), blotting out all those parts which are out of focus. In other words, it gives you a truthful picture of a definite plane in the structure. To illustrate this I have selected the thinnest and most transparent histological object, and one which would be more likely to be blotted out than any other with which I am acquainted. I have photographed this both with a wide and narrow cone, and you shall judge for yourselves which is the more faithful picture. The object is cartilage in a young rat's tail, of which I will project a low power view, × 8, in order that you may identify it. I now show you an image (fig. 17), × 390 diams., taken with a small cone. The most prominent features in this image are the parts which are out of focus. I wish to draw your particular attention to a cell-wall seen end-on running nearly in a vertical direction in the centre of the slide. The focus was adjusted precisely on that point, and I would like you to notice the apparent thickness of that line.

I will now show you the same object (fig. 18) taken by a large cone, and you will at once understand the extreme tenuity of that particular cell-wall which in the previous picture was so thickened by false diffraction ghosts. This picture, I maintain, is a true representation of an exquisitely thin cell-wall; there is no blotting out of any structure in focus, only a removal of false diffraction ghosts. Of course it may be useful to produce a false image for the purpose of obtaining an idea as to the relative position of the part in focus to those parts out of focus. But this has nothing to do with the bare fact of the obliteration of structure by means of a wide cone.

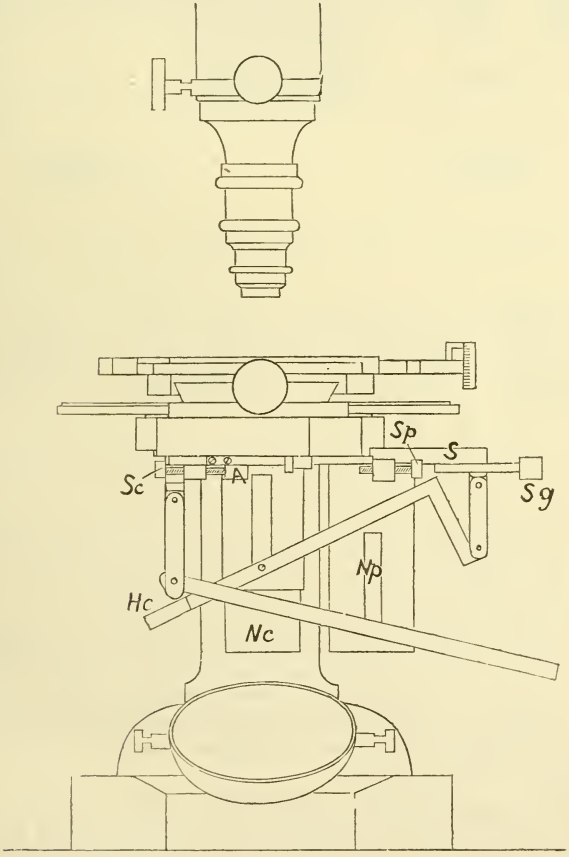
In conclusion, I believe the objection to the use of a narrow-angled cone to be due to the fact that it emphasizes zonal differences, and the efficacy of the wide-angled cone that it as far as possible neutralizes the effect of those differences. Prof. Abbe states (p. 724) "there is not the least rational ground, nor any experimental proof, for the expectation that this mixture [he is alluding to the mixture of slightly dissimilar images in consequence of the employment of a wide cone] should come nearer to a strictly correct projection of the object than that image which

* R.M.S.J., 1889, Part 6, p. 723.

is projected by means of a narrow axial illuminating pencil." Now, I take it that I have proved to you this evening one thing at least, that there is rational ground and experimental proof for the expectation that this mixture does come very much nearer to a strictly correct projection of the object than that image which is projected by means of a narrow-angled illuminating pencil. Finally, I am of opinion that a correct understanding of diffractional effects will, more than anything else, tend to produce in the minds of microscopists a true appreciation of the importance of the achromatic condenser."

Apparatus for the rapid change from parallel to convergent polarized light in connection with the Microscope.*—Dr. E. A. Wülfing gives a description of an apparatus invented by himself,

FIG. 4.



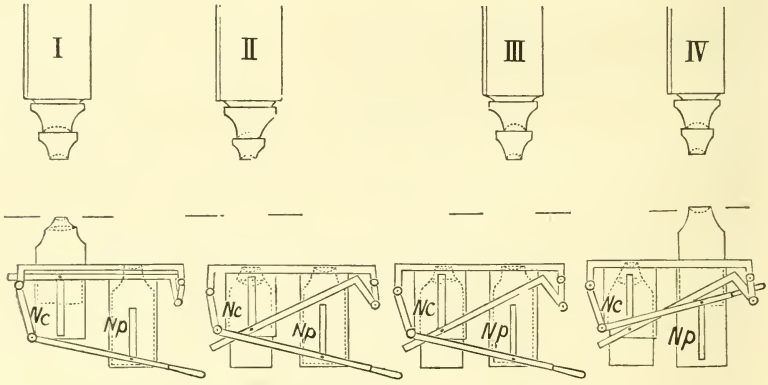
intended to save time in studying mineral or rock sections by polarized light. A plate S (fig. 4), sliding in a groove beneath the stage of the

* Neues Jahrb. f. Mineralogie, 1889, ii. p. 199–202.

Microscope, bears on its under surface two vertical tubes containing two Nicol prisms N *c* and N *p*, one of which N *c* is permanently arranged for observation by convergent light, i. e. with the usual two convergent lenses, whilst the other N *p* bears the usual lens employed in observations by so-called parallel light. Both of these polarizers, together with their lenses, can be raised or lowered independently of one another by means of suitable forked two-pronged levers H *c* and H *p*.

When changing from one form of illumination to the other, the Nicol prism last in use is pushed down, the plate S is slid in its groove so as to bring the other Nicol to the centre of the stage, and this second Nicol is then raised by its lever into position beneath the mineral section. These four stages in the process are shown in the diagrams I. to IV. (fig. 5), where I. shows Nicol N *c* in its highest position,

Fig. 5.



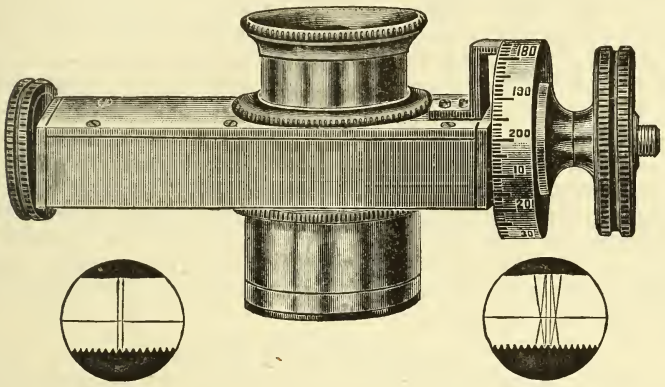
beneath the section; Nicol N *p* in its lowest position on one side, not in use. II. Nicol N *c* in its lowest position beneath the section; Nicol N *p* in its lowest position on one side, as before. III. Nicol N *c* in its lowest position, pushed aside; Nicol N *p* in its lowest position beneath the section. IV. Nicol N *c* in its lowest position, pushed aside as before; Nicol N *p* in its highest position beneath the section.

The catch or stop at A can be turned aside to permit of both polarizers being pushed aside for observation by ordinary light. Dr. Wülfing has the apparatus attached to a Fuess No. 1 large Microscope. It would require special fitting to other patterns. The apparatus is made by Zimmermann, Mechaniker, Hauptstrasse, Heidelberg, and costs, without Nicol prisms and lenses, 60 marks. It will be observed that two polarizers are required.

Bulloch's improved Filar Micrometer.—Fig. 6 shows this instrument, of which a short description was given in this Journal for 1886, p. 132, in which we described it as having a second screw, worked by a milled head at the opposite end to the micrometer-screw, which moves both sets of lines together, so that it is possible to set the graduated screw-head at zero for any particular measurement.

Mr. Bulloch now describes it as follows:—"The improvement consists in the secondary slide, by which the whole micrometer is movable; avoiding the uncertainty of adjustment made by the ordinary micrometer in getting contact with the cross-hair at zero; as the amount of

Fig. 6.



spring with the best mechanical stage (excepting micrometer stages) prevents the cross-hairs being brought gently and perfectly in contact with the object to be measured."

Mr. Bulloch writes as follows with regard to the additional diagonal lines shown in one of the small figs.:—"From my experience in comparing micrometers and getting the value of divisions of the screw, much better results can be reached by intersecting the line on the micrometer with the cross line in the eye-piece micrometer; for when using the ordinary filar micrometer it is almost impossible to judge the amount of space left between the line on the micrometer and the spider line."

(4) Photomicrography.

Photomicrographs and Enlarged Photographs.—At the December meeting of the Society, Mr. J. Mayall, jun., read the following note:—

The application of photography to microscopy has received in recent years so great an impulse from the introduction of the dry-plate processes, that the Society has received very large accessions to its collection of photographs—especially of such as have been produced with a view to illustrating various theories of diatom structure.

Apart from the question how far it is legitimate to infer the structure of such diatom valves either from the images seen in the Microscope or from those produced by photomicrography—a question which Prof. Abbe's researches appear to answer in the negative—it appears to me that, unless great discretion is used, the after-processes of enlarging from photomicrographs may easily lead microscopists astray in giving fictitious appearances of contrast in the structure, leading to the belief that such strong images must necessarily represent what was visible in the Microscope. It is well known that photomicrographs frequently give a very erroneous rendering of the different tints seen on delicate

and transparent objects in the Microscope; and when this erroneous rendering is supplemented by the artificial contrasts due to chemical intensification of the original negatives, or to the after-processes of copying and enlarging, it becomes of the first importance in cases where photographs are brought forward in illustration of special points, that either the original negatives, or reproductions of them as exact as possible, should be exhibited. When, as in many cases—notably by Dr. Van Heurck—enlarged photographs are brought forward without any precise description of the process of their production, and without the original photomicrographs for comparison, useful criticism is difficult if not impossible. All that can be said about them amounts to expressions of vague astonishment that the image should look so strong and so highly magnified. I think it would be advisable in all cases to distinguish between photomicrographs produced with the Microscope, and enlarged photographs from photomicrographs: the former can only be usefully criticized by one who is familiar with the object as seen in the Microscope; the latter need other criteria whence their utility may be estimated, and, above all, they need the presence of the originals from which they were enlarged.

(5) Microscopical Optics and Manipulation.

The full Utilization of the Capacity of the Microscope, and means for obtaining the same.*—In a paper read before the American Society of Microscopists, Mr. E. Bausch said:—The cover-glass may truly be called a necessary evil, for while absolutely required in microscopical investigations, there is no adjunct to the Microscope that has been and is productive of so much evil, and has so retarded the utilization of benefits made possible by the advance in the construction of objectives. This fact was appreciated as early as 1837, when the angular apertures were what would now be considered extremely limited, and the appreciable effect of variations in thickness of cover-glass was not then nearly so pronounced as it is at the present time, even in modern objectives of a narrow angle.

The accommodation for the different thicknesses was obtained by varying the distance between the systems of objectives, and has been followed with modifications in the mode of obtaining the necessary motion up to the present day. While open to some objection, it accomplishes the purpose quite satisfactorily, and must continue to be used until something better is suggested.

One of the purposes of the homogeneous immersion is, as we know, the avoidance of the necessity of the cover-correction, in that the cover-glass, immersion fluid and front of objectives are to be one homogeneous mass, but even under these conditions, which in practice were found to be not constant, it has been found advisable to provide cover-correction to obtain the highest possible results. However, even should this not be found necessary in the development of improvements in this class of objectives, it must be remembered that the majority of objectives will always be dry, and especially so when such improvements, which we hope are still to be made, are accomplished. It is an unfortunate circumstance that with this class of objectives the influence of variation

* Microscope, x. (1890) pp. 289–96.

in thickness of cover-glasses is most apparent; but since it is so, we should, if possible, provide an agency which, eliminating the personal factor of efficiency, will give under all conditions, results closely equal to those under which the objectives were originally corrected.

It is surprising to see how little attention is paid to this subject in the large majority of standard works on the Microscope. Almost all books give carefully prepared illustrations and descriptions showing the effect on the course of light by the interposition of the cover-glass, and after giving conclusive evidence of its disturbing influence, still, in a general way, say it is of little moment. Thus, in a German work of the highest standing, which has also been translated into the English language, is found the following utterance, freely translated:—

"In regard to modern Microscopes, which we have had opportunity to examine, we have not found the differences in thickness such as occur in commercial cover-glass, when, for instance, three to six are equal to a mm., have any noticeable influence on the microscopical image."

In another work of great popularity are found the following quotations:—"That the effect of thickness of cover-glass has a great influence on the perfection of the microscopical image is beyond the slightest question, and certainly deserves the most careful attention of the optician as well as the observer, but whether the devices for its removal are of such great importance and so absolutely necessary as it is claimed, is another question."

"On the other side, the difference in the cover-glass used in different directions for the most delicate preparations is hardly of any account. I, at least, possess, besides my individual preparations covered with glass of about 1/5 mm. thickness, a collection of objects which I obtained from London and Paris, in which there is such a slight difference of cover-glass thickness that I can observe them all with my objectives of powers from 2 to 1·3 mm. (equivalent to about 1/12 to 1/20 in.) without showing the slightest difference in optical qualities, and in the definition and clearness of the image under the same illumination, as I have convinced myself by careful comparative tests."

With such statements to guide the microscopists, it is not surprising that the subject should have received so little attention, and that any efforts to lead to improved methods of manipulating objectives should have almost completely failed because of a lack of the true understanding of their need and consequent failure to create interest. The belief is quite general that any time devoted to this subject is wasted, and might better be utilized in other directions. I hope to be able to show that this is entirely wrong, and may here say that while I may be considered an extremist in the other direction, my efforts emanate from the desire to put it in the power of every microscopist to obtain the highest possible results from his optical battery, and equal to those obtainable by the optician.

When, in 1887, Prof. S. H. Gage addressed a circular letter to all opticians in the world inquiring for the dimensions of their standard tube-length, as well as for the thickness of cover-glass which they used as a standard in the correction of objectives, I looked forward to the result with considerable interest, as it would bring together data which it was impossible otherwise to obtain.

At the meeting of this Society in 1887 at Pittsburgh, he gave the results of his efforts, which show some astonishing facts. I would here say that while for a long time I had felt that a system that would permit the full utilization of the optical capacity of objectives of different makers under varying conditions of cover-glasses was desirable, I was then forcibly impressed with the absolute necessity of a plan which would offer this advantage. One is as much surprised by the differences in cover-glasses used by various makers in correcting non-adjustable objectives, as by the great differences in the length of tube, which influences so considerably the spherical aberration of the objectives. With a thickness of 0·1 mm. for the thinnest, and 0·25 mm. for the thickest, it is only too apparent that with the additional variation in lengths of tubes, it is beyond the power of the microscopist to obtain even approximately the best results from his objectives. More than this, a large quota of the advance made in recent years in the capacity of objectives has been lost.

As Prof. Gage states, "A uniform thickness for cover-glass for unadjustable objectives seems also desirable," and this would be the easiest solution of the question, but while, on the one hand, the makers of objectives have not yet agreed to use one standard on account of the technical difficulties involved in departing from their established precedent, on the other, the microscopist would hardly be willing to bear the expense which would be occasioned by the loss of cover-glass not conforming to the standard, in order to use those of one thickness. This expense might be greatly reduced by using selected covers of one standard on objects for all medium and high-power objectives, and the balance on all other preparations, on which only low powers would be used, but this would of course be of little avail in face of the fact that manufacturers follow no standard.

The greatest difficulty is met with non-adjustable objectives. As is well known, compensation for thickness may be obtained in the proper adjustment of tube-length, but while not all Microscopes are suitably provided with draw-tubes, the requisite experience and skill are lacking with a large number of microscopists to make the correction properly in this manner, as well as in objectives especially provided with collar correction. I am sure that microcopists of long experience will bear me out in the statement that results with adjustable objectives depend upon individual skill, and that many such objectives now in use fail to give results corresponding to their capacity. It would seem, therefore, that any system to permit the full utilization of the capacity of objectives should depend on no personal factor, in fact, should be mechanical, and this I have followed out in the system that I shall explain.

In an objective corrected for normal thickness of cover-glass there will be spherical over-correction with thick covers and under-correction with thin covers, the amount of correction varying in a different ratio to the amount of variation from the normal thickness. The chromatic correction will also lose correspondingly, but not to so high a degree. While a deviation of a few hundredths of millimeter in either direction will not signify, that which occurs in covers classified in price lists under one number is sufficient seriously to affect, and in the higher powers totally obliterate the definition, which under normal conditions it may possess.

The microscopist is therefore not obtaining such results as his objectives should enable him to obtain, and the efforts of the conscientious optician to provide classified objectives of reliability and similar performance are almost entirely nullified. In making the necessary experiments some astonishing results appear. With a non-adjustable dry 1/5 corrected for a cover-glass of 0·16 mm., employing the extremes of cover-glass

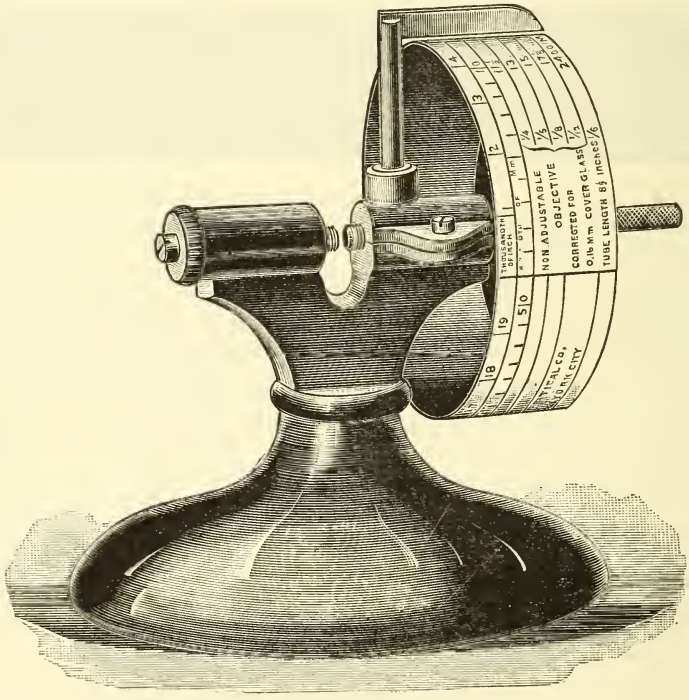
Fig. 7.

which are used by the various manufacturers as standard as obtained by efforts of Prof. Gage, I found that for 0·25 mm. a tube-length of 6 in. is required to obtain the proper correction, while for a thickness of 0·1 mm. 13 in. of the tube-length are necessary. In a 1/8 objective adjusted under the same conditions, 4½ in. are the requisite for a cover of 0·25 mm., and for 0·1 mm. 15 in. The further fact is shown that with a 1/5, which under conditions of tube-length and cover-glass given above shows certain structure well defined, absolutely fails to show anything of it under a cover-glass of 0·1 mm. on one side and 0·25 mm. on the other, and further a marked chromatic over or under correction. With a cover of 0·14, which would seem but a slight variation from the standard, the objective is spherically highly under-corrected, and with 0·18 highly over-corrected. With objectives of high power the difference is still more marked. For these experiments I have had Mr. J. D. Möller, of Germany, mount a series of *Pleurosigma angulatum* dry and *Amphipleura pellucida* in balsam under a series of covers varying from 0·1 mm. to 0·34 mm. each carefully measured and marked. I have used these objects because they are my favourite tests, and it goes without argument in saying that any preparation showing structure under the above objectives will be affected to the same extent by the varying conditions of cover-glass as these objects, and in objects of still finer structure the limit of visibility will be reached correspondingly sooner.

The system which I have devised to aid in overcoming these difficulties depends in the first instance upon a micrometer for measuring the thickness of cover-glass. While the delicate instruments made by M. Grossman, of Germany, are excellently suited for this purpose, they are expensive. I have endeavoured to overcome this objection by constructing a plain screw which, while not so sensitive to the touch, is sufficiently so for all practical purposes. The instrument is provided with a stand of japanned iron. Cut horizontally through the top is a thread of 1/50 in. pitch, and 3/16 in. outside diameter; a recess is cut on the top below the line of the screw, and at right angles to it for placing the covers. The one-half of the top of the stand which receives the micrometer screw is slotted longitudinally to the depth of the screw, and is provided with a set screw to take up wear. The other half has the

fixed screw, adjustable, however, for final adjustment. The end of the micrometer screw is milled, but of a small diameter, so that no force can be exerted to endanger the cover-glass. Fixed on the screw between two nuts is a brass drum with a 1/2 in. face; a knife-edge index-finger is fixed to the top of the stand, and projects over the top of the drum; to the outside diameter of the drum is fixed a strip of glazed paper

Fig. 8.



Actual size.

provided with a series of divisions. The first gives the thickness of cover-glass in thousandths of in., the second in hundredths of mm. The third indicates the proper tube-length with various thicknesses of cover-glass with a non-adjustable 1/4 corrected under a tube-length of $8\frac{1}{2}$ in., and cover thickness of 0·16 mm.; the fourth gives the tube-length of a 1/5 in. objective under the same conditions; the fifth for a 1/8, and the sixth for a 1/12 for same conditions of tube-length and cover; the seventh is for a 1/6 with the same cover, and tube-length of 160 mm.

In objectives provided with cover correction the graduation is so arranged as to read to 0·01 mm. No matter what the power of objective or whether dry or water-immersion, the number gives proper correction for a thickness corresponding to it. Thus, with a cover-glass of

·20 mm. the collar of such an objective needs merely to be set at 20 to give the proper correction, and consequently the best results. On the other hand, with an objective which is graduated on this system, the correct thickness of cover-glasses can be determined by obtaining the proper correction on preparations previously made, but on which the thickness of cover-glass is not noted, and the thickness may be marked on them for future convenience. To do this successfully, however, considerable experience is requisite. All the other scales give the correct tube-length in inches and millimetres for covers corresponding to them, and in this manner offer a ready and definite means of correction. The tube-lengths required for the thinnest and thickest covers are so extreme that probably no convenient means for obtaining them can be practically arranged, but they can be so approximately if not entirely. At any rate, the micrometer will detect the requirements before using the covers, and those deviating considerably from the normal can be used on objects for use with low powers only, in which case the effect will not be very appreciable.

In this system I do not overlook the fact that variation in tube-length involves a variation in magnifying power, but except in cases when micrometers are used, I consider this of secondary importance, as it always is in comparison with the results obtained in resolving and defining power.

This system involves four conditions :—

First. That all cover-glass be measured before using, and that the thickness be noted on the preparation.

Second. That for convenience all draw-tubes be marked in inches or millimetres, or both.

Third. That adjustable objectives be corrected according to this scale.

Fourth. That the same tube-length and cover-glass thickness be used in all original corrections of objectives.

As regards the first condition, there are many microscopists now who measure all their covers before using them, but the mere knowledge of thickness has been of no value up to the present time, because this in itself has been no guide in obtaining better results except by approximation. My aim in connection with this system has been to devise an instrument which shall possess a high degree of accuracy, and shall still be so inexpensive that its price should be no obstacle to its general use.

The celebrated preparer of objects, Mr. J. D. Möller, and others, have kindly agreed to mark the thickness of covers on their objects, so as to aid in the introduction of this system, and other preparers can no doubt be induced to do so if its advantages can be proved.

As regards the second point, many manufacturers now graduate their tubes, and modern requirements demand that this should be more generally done. Our company intends, as soon as it can possibly arrange to do so, to graduate the tubes of all its instruments.

As to the third and fourth conditions, I cannot, of course, presume to ask manufacturers to adapt their standards to this system. While it will be a convenience to a large number of microscopists, I must leave it to the merits that this system may possess, to exert their influence in this direction.

On the Amplifying Power of Objectives and Oculars in the Compound Microscope.*—Dr. G. E. Blackham writes:—"A great deal has been said and written on this subject, and still the matter is not as clear and accurate as could be desired.

The European opticians usually name their objectives and oculars in an arbitrary manner, as No. I., No. II., No. III., &c., or A, B, C, &c., but these designations give no clue to the amplifying powers, except that the lower numbers or earlier letters usually indicate the lower magnifying powers. The No. I. objective of one maker does not, however, necessarily correspond with the No. I. of another maker, and the No. I. objective does not necessarily correspond in amplifying power with the No. I. ocular of the same maker.

The English makers have attempted to avoid this confusion and, to introduce a degree of uniformity, have long adopted a system of nomenclature based upon the amplifying power; that is, if a combination of lenses magnifies equal to a single convex lens of one-inch focus, the combination is *called* a one-inch; if the same as a single lens of one-quarter inch focus, it is *called* a quarter-inch, &c., &c. This system has long been in use in England and this country for objectives, and more recently has been extended to oculars (or eye-pieces, as they are commonly called). This was supposed to give a very simple and accurate means for determining the power of any objective or ocular or combination of objective and ocular, provided only that they were correctly named by the maker and were used on a tube of the standard length. The rule commonly in use is based upon the assumption of the arbitrary distance of ten inches as the distance of distinct vision, and that the number of times the focal length is contained in ten inches is the amplifying power; so that a *one*-inch lens would magnify ten times, a one-fourth inch forty times, a one-tenth inch one hundred times, &c., &c. The image of the object projected by the objective being again magnified by the ocular, it was further assumed that the same rule would apply, and therefore that the amplification produced by the combination of a 1/10 objective with a one-inch ocular would be found by multiplying the assumed power of the 1/10 objective (100) by the assumed power of the one-inch ocular (10) = 1000 diameters. And so, by the application of this simple rule, every owner or user of objectives and oculars of the new nomenclature could calculate correctly the theoretical power of each and of any combination, with the understanding that, if the distance between the optical centre of the objective and that of the ocular varied, the amplifying power would vary in proportion.

The object of the present paper is, 1st, to show the incorrectness of this rule, in that the real image projected by a simple convex ten inches from its optical centre is *not* amplified the number of times the focal length is contained in ten inches, and that the same rule of amplification that is true and correct for the objective that projects a *real* image cannot be true and correct for the ocular, which projects a *virtual* image; and, 2nd, to present a correct method of determining the (linear) amplifying power of any objective or ocular, correctly named on the equivalent focal length system, and of any combination of such objective and ocular at any given distance between their optical centres.

* Proc. Amer. Soc. Microscopists, xi. (1889) pp. 22–31.

Now, in so far as the amplification of the image projected by the objective is concerned, the distance of distinct vision is of no consequence whatever, but the result is governed solely by the well-known optical law that, "The linear dimensions of object and image are directly as their distances from the optical centre of the lens." The correctness of this can be demonstrated by actual measurement, for the image is as real as the object, and its distance from the optical centre of the lens and its dimensions can as easily be measured.

Before proceeding to the further discussion of this subject it may be well to define some of the optical terms which I shall be obliged to use. I am quite aware that, for the majority of my hearers, this is a work of supererogation that almost savours of impertinence; but there are always beginners amongst us, and it is for their sakes that I insert these elementary definitions.

Definitions.—Optical Centre.—The point through which all rays traversing a lens with parallel directions at incidence and emergence must pass. In double convex or double concave lenses it lies in the interior of the lens; in plano-convex or plano-concave lenses it lies on the curved surface; while in a meniscus of either kind it lies outside the lens altogether.

Principal Axis.—The straight line passing through the centres of curvature of both faces of a double convex, a double concave, or a meniscus lens, or passing through the centre of curvature of the curved face and cutting at right angles the plane face of a plano-convex or a plano-concave lens, is called the Principal Axis; the optical centre is always in this line.

Secondary Axes.—All other straight lines passing through the optical centre are called "Secondary Axes."

Principal Focus.—The point at which rays originally parallel to the principal axis are made to converge (approximately) to one point.

Focal Length.—The distance from the optical centre to the principal focus.

Conjugate Foci.—Rays emerging from a point more distant than the principal focus on one side of a convex lens and passing through the lens will be brought to a focus at a point on the other side of the lens, and the points thus related are called conjugate foci.

As one conjugate focus advances from infinite distance (parallel rays) to the principal focus, the other recedes from the principal focus to infinite distance, the most distant focus always moving most rapidly, and the least distance between them is therefore attained when they are equidistant from the optical centre, in which case the distance of each from the optical centre is $2f$, and their distance from each other $4f$. If either is less than the principal focus, then the other becomes negative; that is, the rays are no longer brought to a focus on the *opposite* side of the lens, but are only rendered less divergent, as if coming from a more distant point on the *same* side, and this point from which they *appear* to come (the more distant of the two) is called the virtual conjugate focus. In this case, as one conjugate focus advances towards the optical centre, the other advances in the *same* direction till they become coincident.

Secondary principal and conjugate foci exist in each of the secondary

axes of a convex lens, and are under the same laws as the primary foci.

Each point in an object has its conjugate point in the image of it formed by a lens, and this image, if on the opposite side of the lens, is real and inverted; if on the same side, is virtual and erect. The linear dimensions of the object and image are directly as their distances from the optical centre of the lens; so that, if the object be nearer than the image, then the image is magnified, and *vice versa*.

Formulæ.—The formulæ for the determination of the conjugate foci when

f = principal focus (or focal length);
p = one conjugate focus;
p' = the other conjugate focus.

When the conjugate foci are on opposite sides of the lens (real image):

$$\frac{1}{p} + \frac{1}{p'} = \frac{1}{f}.$$

This formula suffices for the determination of either of the conjugate foci, the other conjugate focus and the focal length being given; or of the focal length, the two conjugate foci being given; and as it applies equally well to points in the secondary axes, it suffices equally to determine the distances of the object and image (and thence their relative linear dimensions), if one of these distances and the focal length of the lens be given.

When the conjugate foci are on the same side of the lens (virtual image) the formula becomes

$$\frac{1}{p} - \frac{1}{p'} = \frac{1}{f}.$$

The plus sign here becomes minus, or, to express it in other terms, as the two conjugate foci are now on the same side of the lens, it is the difference instead of the sum of their reciprocals that equals the reciprocal of the focal length. This formula is as applicable as that for real conjugate foci to the determination of the places, and therefore of the relative linear dimensions, of image and object; but, of course, the change of sign produces marked differences in the results when the given quantities are the same; that is to say, with a given focal length and image distance, the distance of the object, and therefore the ratio between its linear dimensions and those of the image, will vary according as the image is real or virtual.

In the compound Microscope we have to deal with both real and virtual images; the real produced by the objective, and the virtual by the ocular.

The real and inverted image produced by the objective becomes in its turn the object of which the ocular produces a virtual image; erect so far as it is concerned, but, of course, still inverted as regards the original object.

The degree of amplification of the real image produced by the objective depends upon two factors: 1st, the focal length of the objective, and, 2nd, the distance from its optical centre at which the image is

formed. It can be formed at any distance from the focal length of the objective up to infinity.

In most Microscopes of the English and American model the tube is of such length that the image is formed at a distance of about ten inches, and that distance is therefore taken as the basis of calculation, and the formula then is

$$\frac{1}{p}\ \frac{1}{\text{(object distance)}} + \frac{1}{p'}\ \frac{1}{\text{(image distance)}} = \frac{1}{f}\ \frac{1}{\text{(focal length)}};$$

or, substituting the image distance 10 for p':

$$\frac{1}{p} + \frac{1}{10} = \frac{1}{f}.$$

With this formula let us work out the case of a 5-in. objective; then

$$\frac{1}{p} + \frac{1}{10} = \frac{1}{5};$$

$$\frac{1}{p} = \frac{1}{5} - \frac{1}{10} = \frac{1}{10};$$

$$\frac{p}{1} = \frac{10}{1};$$

$$p = 10;$$

that is, the object and image are equidistant from the optical centre, and therefore of equal size, and there is no amplification. Of course, it can be assumed that the image distance p' is greater than 10 in., as in case the draw-tube is used, when the formula will show that, with a 5-in. objective, the image is larger than the object, or p' can be taken as less than 10 in., when the formula will show that, with a 5-in. objective, the image is less than the object.

Keeping 10 in. for our image distance, let us take the case of a 1/5 in. objective, then $f = \frac{1}{5}$.

$$\frac{1}{p} + \frac{1}{10} = \frac{1}{\frac{1}{5}}$$

$$\frac{1}{p} + \frac{1}{\frac{1}{5}} - \frac{1}{10} = \frac{50}{10} - \frac{1}{10} = \frac{49}{10}$$

$$p = \frac{10}{49}$$

$$a\ \text{(amplification)} = \frac{10}{\frac{10}{49}} = 49\ \text{times.}$$

By this formula we can easily calculate the amplification of the real image projected at 10 in. by any simple-convex lens, if the focal length

of the lens be known; and I present herewith a table so calculated for most of the focal lengths used for Microscope objectives. (Table A.)

It will be noted that the amplifications obtained are, in every case, less than those obtained by the number of times the focal length is contained in 10 in., and the reason is that one conjugate focus (the image distance) being at less than infinite distance, the other conjugate focus (the object distance) *must* be at a greater distance than the focal length, and therefore a quantity greater than the focal length must be used for the divisor, and the quotient (the amplification) must be less.

As a 1-in. simple-convex lens amplifies the image projected by it at 10 in. from its optical centre 9 times, a 1-in. objective should do the same (without reference to its actual focal length). If it fails to do so, if the image projected by it at 10 in. from its optical centre is amplified more or less than 9 times, then the objective has been incorrectly named; it is not a 1-in. objective, but something else.

The Ocular.—Having disposed of the real image projected by the objective, we come to the virtual image projected by the ocular; here the formula is

$$\frac{1}{p} - \frac{1}{p'} = \frac{1}{f};$$

substituting the image distance 10 for p' we have

$$\frac{1}{p} - \frac{1}{10} = \frac{1}{f}.$$

With this formula let us work out the case of a 5-in. ocular:

$$\frac{1}{p} - \frac{1}{10} = \frac{1}{5}$$

$$\frac{1}{p} = \frac{1}{5} + \frac{1}{10} = \frac{3}{10}$$

$$p = \frac{10}{3}$$

$$a = \frac{10}{\frac{10}{3}} = \frac{30}{10} = 3 \text{ times.}$$

The wide difference of this result from that obtained for a lens of the same focal length used as an objective shows very plainly the absurdity of using, as many of us have done, and as many of the books teach, the same general rule for determining the amplifying power of objective and ocular, viz. to divide 10 in. by the focal length expressed in inches.

I present herewith a table of amplifications of virtual images projected at 10 in. by simple lenses corresponding to the most commonly used oculars. (Table B.)

The total amplifying power of any combination of objective and ocular is obtained by multiplying the amplifying power of one by that of the other.

For instance, the total amplifying power of a Microscope with tube of standard length carrying a 1-in. objective and a 2-in. ocular should be $9 \times 6 = 54$, instead of $10 \times 5 = 50$, as per the usual rule.

It is to be noted, however, that while the formulæ here given are theoretically correct for the objective and ocular respectively, and are applicable to any image distances by substituting the desired image distance for p', as 10 was substituted for it in the examples given, yet there are many complications in the practical application of any formula to the determination of the actual amplification obtained by the modern compound Microscope; among these complications are,

1st. The highly complex construction of many objectives, making it very difficult to ascertain with any degree of accuracy the position of the optical centre, which difficulty is still further increased when the objective under consideration is furnished with a correction arrangement for various thicknesses of cover-glass, which, by varying the relative positions of its component lenses, varies its actual and nominal focal length and the position of its optical centre. The exact position of the optical centre of the ocular is also, at times, difficult of determination.

2nd. The refractive condition of the observer's eye is also a factor in the amplification under which the image is finally *seen*, for the reason that the dioptric system of the observing eye becomes, in fact, a part of the ocular, and any difference of its refractive power greater or less than that required to focus on the retina rays proceeding from a radiant situated at the given image distance, must be added to or subtracted from the refractive power of the ocular, and thus decrease or increase its focal length. That is to say, a person who can and does accommodate for precisely 10 in. while looking through the Microscope will, if all the other conditions are rigidly complied with, see the image under the exact amplification indicated by the formula, while one, who by reason of myopia or of excessive use of the muscle of accommodation accommodates for a less distance, will see it under a greater amplification, and the emmetrope or hyperope who relaxes his accommodation to less than that required to bring rays from a radiant at 10 in. to a focus on his retina, will see it under a less amplification than that indicated by the formula. For instance, let us take the case of the combination of 1-in. objective and 2-in. ocular for which we have found the total amplication, when image distances are taken as 10 in. in case of both objective and ocular, to be $9 \times 6 = 54$. If the observing eye be accommodated for just 10 in., the image will be seen clearly and under an amplification of $\times$ 54. If, however, the eye is accommodated for any other distance, then the image will not be clearly seen and a change must be made in the adjustment of the Microscope to make it clear. The reason is that the excess or defect of the refraction of the eye above or below what is required to accommodate it to 10 in. has, in effect, been added to or taken from the refractive power of the ocular.

Suppose an observer, as the result of myopia or from spasm of, or voluntary action of the muscle of accommodation, accommodates for a distance of 5 in. instead of 10 in.; he has, in effect, added to the refractive power of the ocular the refractive power of the lens which represents the difference between a refractive power of 10 in. and of

5 in. The refractive power of a lens is the reciprocal of its focal length. Hence the equation is

$$\frac{1}{5} - \frac{1}{10} = \frac{1}{10}.$$

Then refractive power of ocular + excess of ref. of eye = ref. power of eye and ocular taken as one, or

$$\frac{1}{2} + \frac{1}{10} = \frac{6}{10} = \frac{1}{1{\cdot}66}.$$

Hence the resulting amplification will be as if the ocular had a focal length of $1{\cdot}66$ instead of 2, and the formula will be

$$\frac{1}{p} - \frac{1}{10} = \frac{1}{1{\cdot}66}$$

$$\frac{1}{p} = \frac{1}{1{\cdot}66} + \frac{1}{10} = \frac{11{\cdot}66}{16{\cdot}6}$$

$$p = \frac{16{\cdot}6}{11{\cdot}66}$$

$$a = \frac{10}{\frac{16{\cdot}6}{11{\cdot}66}} = \frac{1166}{16{\cdot}6} = 7.$$

Hence for the observer whose eye is accommodated for 5 in., the expression for total amplification of the 1-in. objective and the 2-in. ocular will be $9 \times 7 = 63$.

On the other hand, let us take a case much more unlikely to occur in practice, that of a person who by reason of excessive hypermetropia or paralysis of accommodation, is unable to focus any but parallel rays upon his retina, or, in other words, to accommodate for any point nearer than infinite distance. If such an observer make use of the same combination of objective, he has in effect subtracted from the refractive power of the ocular the refractive power of the lens, which represents the difference between a refractive power 0 and of 10 in. = 1/10; then

$$\frac{1}{2} - \frac{1}{10} = \frac{4}{10} = \frac{1}{2{\cdot}5}.$$

Hence the resulting amplification will be as if the ocular had a focal length of $2{\cdot}5$ instead of 2, and the formula will be

$$\frac{1}{p} - \frac{1}{10} = \frac{1}{2{\cdot}5}$$

$$\frac{1}{p} = \frac{10}{25} + \frac{1}{10} = \frac{125}{250} = \frac{1}{2}$$

$$p = 2$$

$$a = \frac{10}{2} = 5.$$

Hence, for the emmetropic observer whose accommodation is entirely relaxed, or for any observer whose eye is accommodated for parallel rays, the total amplification of the 1-in. objective and the 2-in. ocular will be $9 \times 5 = 45$.

For strict accuracy, the change in the position of the image produced by the objective, if the adjustment for the different eyes be produced in the usual way by means of the fine or coarse adjustment moving the objective to or from the object, should be taken into consideration, but the amount is so small, about $2\frac{1}{2}$ per cent. in the first case, and 5 per cent. in the second, that it may be neglected without seriously impairing the practical accuracy of the general result, while if the adjustment for different eyes be made with the draw-tube moving the ocular only, the position of the image produced by the objective is not changed, and therefore, so far as it is concerned, the original formula remains strictly correct."

"TABLE A.

"Amplification (linear) of Real Images projected at 10 in. from optical centre by simple bi-convex lenses.

Focal Length of Lens in inches.	Linear Amplification of Image.	Focal Length of Lens in inches.	Linear Amplification of Image.
5	1	1/4	39
4	1·5	1/5	49
3	2·33	1/6	59
2	4	1/7	69
1	9	1/8	79
3/4	12·33	1/9	89
2/3	14	1/10	99
1/2	19	1/12	119
4/10	24	1/16	159
1/3	29	1/25	249

TABLE B.

"Amplification (linear) of Virtual Images projected at 10 in. from optical centre by simple bi-convex lenses.

Focal Length of Lens in inches.	Linear Amplification of Image.	Focal Length of Lens in inches.	Linear Amplification of Image.
5	3	3/4	14
4	3·5	1/2	21
3	4·33	4/10	26
2	6	1/3	31
$1\frac{1}{2}$	7·73	1/4	41
1	11		

"NOTE.—In the Huyghenian ocular (the form most commonly in use) the field-lens, while mechanically part of the ocular, is optically part of the objective, in that it contributes to the formation, not of the virtual image projected by the ocular, but of the real image projected by the objective, upon which it acts negatively, diminishing its size while increasing the superficial area brought into view at one time. So that, in this form of ocular it is the eye-lens alone that contributes to the reamplification of the image, but the negative action of the field-lens must, of course, always be taken into consideration when attempting to determine the amplifying power of a Huyghenian ocular by calculation."

New Method for Constructing and Calculating the Place, Position, and Size of Images formed by Lenses or Compound Optical Systems.* —The late Prof. G. Govi wrote:—"The theory of lenses and of compound systems has taken a new form, and reached far greater perfection since Moebius, Gauss, Listing, and others have introduced the consideration of certain planes and cardinal points, which simplify the construction of the place, position, and size of the images, allowing account to be taken of the thickness of the refractive medium traversed by the light. But the preparatory operations, either as constructions or calculations, by which we succeed in determining the place of the points and cardinal planes in lenses or systems, are long and wearisome, and often out of proportion to the importance of the result we hope to obtain; and, above all, it is always most difficult to determine by experiment the place of these planes and points in lenses already worked or in optical systems already constructed.

Physicists, therefore, in spite of the practical methods and instruments proposed for the purpose by Cornu, Gariel, and others, are for the most part limited to considering the lens as having no thickness, and to calculate directly and for every limiting surface the path taken by the rays in traversing the given media, thus sacrificing a part (and at times not a small one) of the necessary precision, or increasing the fatigue of the calculations when many determinations of the same optical system are in question.

The suggestion, therefore, of a quicker method for constructing and calculating the images given by thick lenses will not be unwelcome to students, the same method being also applicable to any optical system whatever.

This method requires the determination of two points which, very probably, have not until now been taken into consideration by physicists or mathematicians who have treated of these matters; probably they passed them unawares, because if any one had pointed out their importance and usefulness they would at once have been recognized, and the very latest treatises on optics would have recalled them.

The two new points, by which the theory of lenses is very much simplified, and which are easily determined by observation, are the images of the centres of curvature of the two faces, anterior and posterior, of the lens, seen through that one of the two faces to which they do not belong. In order to obtain them it is necessary to suppose that the luminous rays diverging from the centre of curvature of one face, or converging towards it, meet the second face of the lens where by refraction they are made to converge towards the image of this same centre, or diverge from that image when it becomes virtual. We thus have on the axis of the lens the places of the two images q and q_1, (fig. 9), of the centres c and c_1, and of the curvature of the two faces al and bl_1.

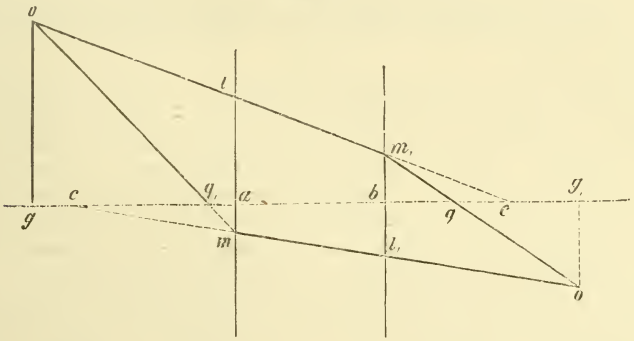
Having fixed the position of these two points, which we may call the centric points of the given lenticular system, nothing else is needed to determine any conjugate focus of a point situated upon the axis or outside the principal axis of the system, and to obtain the size and position

* Rend. R. Accad. Lincei, iv. (1888) pp. 655–60 (3 figs.).

of the real or virtual images which may be produced by the system itself.

The determination *à priori* of these points (like the determination of the points and planes of Gauss and Listing), demands the knowledge of the length and sign of the radii of curvature of the two surfaces of the lens, that of the thickness of the lens, or the axial distance of the two refracting surfaces, and finally that of the relative velocity of light in the three successive media—that is to say, of their relative indices of refraction. We can with these data alone construct or calculate the

Fig. 9.



place of the centric points q and q_1, without first determining the principal foci and the principal distances or anterior foci of the two surfaces of the lens; we can also, if we wish, determine these quantities which, introduced in successive calculations or in ulterior constructions, abbreviate or simplify the work.

In any case, having obtained the two centric points, we have no further need either of the optic centre, or of its two images, or the nodal points of Listing, or Gauss' principal planes, or the principal foci of the whole lens, to construct or calculate the places, positions, and size of the images. And as such constructions are made very quickly, we may use them in order to find the final effect of any series whatever of surfaces and of different refracting media, centered on the same axis.

It is not, therefore, necessary in the case of optic systems to have recourse to the laborious process of construction or calculation by means of successive images, for there can always be determined in every optic system (however complex) the images of the centres of curvature of its first and of its last surface, seen successively through the whole of the rest of the system, observing the image of the centre of the first surface through the second, then the image of this image through the third, and so on to the image of all the preceding images, seen through the last surface, and repeating the same operation in the opposite direction for the centre of the last surface and for its successive images up to the last, which is seen through the first surface. In this way the centric points of the whole system are obtained, by means of which we

can construct afterwards or can calculate with great rapidity the image of any point placed at any distance whatever from the system.

The greater simplicity of the new method arises from considering those rays which undergo neither deviation nor displacement either at the entrance into or exit from the different media, so that the faces of the lens or the external surfaces of the system perform the function of the principal planes of Gauss, the centres of curvature of these surfaces that of the nodal points of Listing, and their images or centric points that of the principal foci of the optic system.

Without now entering into minute details of the new method, it will be sufficient to show how, by having recourse to it, we can easily find the centric points of a given lens, and how, once these points are found, we can easily construct the image of any object seen through the lens. We shall thus see whether the proposed method deserves or not to be preferred to others.

In order to find practically the position of the centric points of a given lens, we measure its thickness γ, and with the spherometer, or by reflection or otherwise, the radii of curvature r and r_1 of its first and second surfaces. Having obtained these quantities we place normally to the axis of the lens an object of a known size $o\,g$, at a determinate distance $a\,g$ from one of the faces, and we find the image $o_1\,g_1$ either real or virtual of the object, seen through the lens, measuring this image, and determining its distance $b\,g$ from the other surface.

Then by drawing a straight line from the extremity o of the object to the centre c of curvature of the first face of the lens, this straight line will cut the last face in a certain point m_1; by drawing a straight line from the extremity o_1 of the image to the centre of curvature c_1 of the last face, we mark by m the point in which this straight line cuts the first face of the lens. Join o_1 to m_1, the point q, in which the straight line $o_1\,m_1$ cuts the axis of the lens, will be the first centric point, that is, the place of the image of the centre c of the first face seen through the second. Let o be similarly joined to m, the point g_1, in which the line $o\,m$ cuts the axis, will be the second centric point, that is, the image of the centre c_1 of the second face seen through the first. Having thus obtained the points q and q_1, the construction of the principal or conjugate foci of the system and that of all the images which it can give, can be made exceedingly rapidly, and we can then deduce very easily the places of the principal planes, the nodal points, the optic centre, &c., if we wish to treat the problems relating to the given lens by the methods of Gauss, Listing, or other mathematicians.

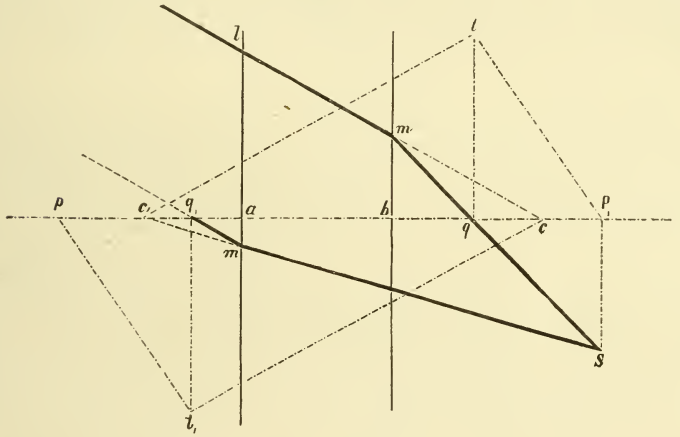
The preceding diagram shows at once how we may obtain the image of a point o placed outside the axis of the lens. (If the point given were on the axis, we might raise from it a perpendicular to the axis, and determine the image of any point on this perpendicular, drawing from the image obtained a normal to the axis itself. The meeting point of this normal and the axis would be the place of the image of the given point.) Let a straight line be drawn from the point o to the centre c of the face through which it is intended the light should pass; such a straight line will represent a luminous ray, which starting from o will pass, neither deviating nor displaced through the lens, until it meets in m, the second face. The ray having reached m, will deviate towards the

point q, the image of c; draw the line $m_1\ q$ on which prolonged will be found the image of o. From the point o draw through q_1 the line $o\ q$, until it meets the first face of the lens in m. Through m and c_1 draw the line $c_1\ m$, which prolonged will pass without deviation out of the lens, and will meet $m_1\ q$ in a point o_1; the point o_1 will be the image of o.

If from the point o the perpendicular $o\ g$ be let fall on the axis, and from o_1 the line $o_1\ g_1$, the point g_1 will be the place of the image of the point g seen through the lens.

In order to obtain the principal foci of a given lens, draw a radius $l\ c$ (fig. 10) to the centre of its first face, and draw its corresponding refracted ray $m_1\ q$, then through the point q_1 draw $q_1\ m$ parallel to $l\ c$, drawing $m\ c_1$ and prolonging it till it meets $m_1\ q_2$ prolonged in S.

FIG. 10.



The point S will be the image of a point situated at an infinite distance in the direction of $c\ m\ l$. Drawing from S a normal to the axis we obtain in p_1 a principal focus of the lens. The same construction repeated for the other face will give the second principal focus p, or the point of the principal distance of the lens.

We can obtain the second focus more quickly when once the first is known, profiting by a very simple relation which exists between the two distances $q\ p_1$ and $q_1\ p$ of the two principal foci from the centric points.

Representing by r the radius of curvature $a\ c_1$ of the first face of the lens l_1, by r the radius $b\ c_1$ of the other face, by x the distance $b\ q$ of the centric point q from the second face of the lens, by x_1 the distance $a\ q_1$ of q_1 from the first face, and denoting by F the distance $q\ p_1$ and by F_1 the line $q_1\ p$ we readily obtain the following relation :—

$$\frac{F - r_1 + x}{F_1 - r + x_1},$$

which gives directly F, if we know F_1, or F_1 when F is known.

The construction of this formula is very simple. From the points q and q_1 let two normals be drawn to the axis; through the centre c draw $c\ t_1$ until it meets in t_1 the normal passing through q_1; let $c_1\ t$ be drawn through the centre c_1 parallel to it, until it meets in t, the other normal $q\ t$. Having then joined the principal focus p (which we suppose to be known) with t, let a parallel to $p\ t$ be drawn through t_1; the point p_1, where it cuts the axis, will be the other focus, or the principal distance of the lens.

The same graphic process, and therefore the formulas derived from it, are very easily applied also to optic systems composed of lenses without thickness. In this case we first determine the successive images of the centre of the first and of the last lens seen through all the others; then, considering the centres of the lenses as we just before considered the centres of curvature (since we suppose the rays to pass through these centres without deviation and without displacement) we make relatively to them and to their images the constructions already indicated, and so we solve with rapidity all problems relating to optic instruments composed of thin lenses."

(6) Miscellaneous.

"**New Inventions.**"—"Her Majesty's Royal Letters Patent have been granted to the inventor of a wonderful as well as useful little appliance. This is a Pocket Microscope and Floriscope combined, about 3 in. in length and $1\frac{1}{4}$ in. square. It is constructed upon an entirely new principle, and has a magnifying power and definement superior to some of the most elaborate and expensive instruments, and yet so simple that any schoolboy or girl can use it. Its magnifying power is registered as 150 diameters, or 22,500 surfaces, and distinctly shows all the thousands of different kinds of animalcula in water, &c., or any other microscopic objects. This new patent was sealed by the Comptroller-General of Patents on the 13th of August last, and is now offered to the public at the nominal price of 1*s.* each, and sent free by parcel post upon receipt of postal order value 1*s.*—stamps not taken—with a 12-page pamphlet of instructions for use, and a large double sheet of engravings in black and gold (with key) free. The inventors and manufacturers also guarantee that, in any case where the instrument is not approved of and returned within reasonable time, a postal order value 1*s.* will be forwarded by return of post. The medical profession, chemists, schoolmasters, teachers and students, as well as parents and guardians, should send for one on approval. This is no foreign rubbish, but of good English workmanship throughout. Address, Conway Rae & Company, The Premier Patent Microscope Depôt, Stafford Street, Birmingham."

Upon reading the above advertisement in 'Nature' * we applied for one of the Microscopes, and were informed that for an additional remittance of 6*d.* we should receive an instrument of superior make, giving "better definement," with four extra "object-glasses," and a larger pamphlet of instructions. As we were desirous of comparing the two qualities of Microscopes, we requested both to be forwarded.

The lower priced one consists of a tin tube of square section, having a tin diaphragm with square aperture in the middle. At one end is

* October 11th, 1890.

another similar diaphragm of stamped brass fitting after the manner of a cap, but with internal flange; a similar cap, but with deeper flange, is applied at the other end, and this has a circular hole in the centre, against which a blown-glass spherical lens of about 1/4 in. diameter is pressed on the inner side by a tin plate with corresponding central hole. The object is placed between two square plates of glass and thrust up against the lens, a tin diaphragm follows, and these are held in position by a roughly bent piece of tin serving as a spring. The ends of the caps are stamped with an inscription and lacquered; the tin tube is also lacquered.

The higher priced Microscope differs from the other, (1) in having the tin tube coloured in addition to being lacquered; (2) it has four extra pairs of glass plates termed "object-glasses"; and (3) a fuller pamphlet accompanies it.

Whilst wholly disclaiming any desire to depreciate the quality of these Microscopes, we are compelled to state that the whole manufacture suggests that of common toys of tin. And as it would be obviously unfair to compare their optical quality with that of more expensive instruments, we have compared it with a Stanhope lens, such as is commonly sold in the London streets at the price of 1*d.* each, including wire and tin mounting and a pair of glass plates for clipping objects, and our impression is that the latter is not inferior.

The late Mr. Brady, Hon. F.R.M.S.*—We give, almost verbatim, a copy of the best of the notices we have seen of our deceased Fellow. As it is from the pen of Prof. M. Foster, Sec. R.S., it is written by one who knew him well.

Henry Bowman Brady was born on February 23rd, 1835, at Gateshead. His father, an esteemed medical practitioner of that place, belonged to the Society of Friends, and retained to the end the dress and manner of conversation of that body. The father's house, for many years the home of the son, was one of those charming Quaker abodes where strength and quietude sit side by side, and where homely plenty and orderly preciseness hide, for a moment, from the stranger the intellectual activity which is filling the place. Though the son, when I knew him, had abandoned the characteristic dress and speech of the society, without, however, withdrawing from the body, the influences of his surroundings moulded his character, making him singularly straightforward and free from any manner of guile.

After an ordinary school career spent in Yorkshire and Lancashire, and an apprenticeship under the late Mr. T. Harvey, of Leeds, and some further study at Newcastle in the laboratory of Dr. T. Richardson, which may be considered as the forerunner of the present Newcastle College of Science, he started in business in that city as a pharmaceutical chemist in 1855, while yet a minor. That business he conducted with such ability that in 1876 he felt able to resign it to Mr. N. H. Martin, and to devote the whole of his time to scientific work. He contributed to science in two ways—one direct, the other indirect. Of the many scientific movements of the last thirty years or so, one, not of the least remarkable, has been the scientific development of the pharmaceutical

* Nature, xliii. (1891) p. 299.

chemist. Into that movement Brady threw himself with great vigour, especially in his earlier years. He was for many years on the Council of the Pharmaceutical Society, and the progress of that body was greatly helped by his wide knowledge of science and of scientific men and things, as well as by his calm and unprejudiced judgment.

His more direct contributions to science were in form of researches in natural history, more especially on the Foraminifera. His first publication seems to have been a contribution, in 1863, to the British Association as a report on the dredging of the Northumberland coast and Dogger Bank; his last was a paper which appeared in the October number of our Journal. Between these two he published a large number of researches, including a monograph on Carboniferous and Permian Foraminifera, an exhaustive report on the Foraminifera of the 'Challenger' expedition, as well as monographs on *Parkeria*, *Loftusia*, and *Polymorphina*, in which he was joint author.

By these works he not only established a position, both in this country and abroad, as one of the highest authorities on the subject, but, what is of more importance, largely advanced our knowledge. Every one of his papers is characterized by the most conscientious accuracy and justice; and though his attention was largely directed to classification, and to the morphological points therein involved, his mind, as several of his papers indicate, was also occupied with the wider problems of morphological and biological interest which the study of these lowly forms suggests. I have myself often profited by his wide knowledge and power of accurate observation in discussing with him questions of this kind arising out of his studies, and learning from him views and opinions which, to his critical mind, were not as yet ripe enough for publication.

The leisure of the last fifteen years gave him opportunity for travel, and he visited various parts of the world, utilizing many of his journeys —notably one to the Pacific Ocean—in the collection and study of Foraminifera. Some of these travels were undertaken on the score of health, to avoid the evils of an English winter, for he was during many years subject to chronic pulmonary mischief.

During his last journey for this purpose—one to the Nile in the winter of 1889-90—he met with difficulties, and failed to receive the benefit from the change which he had secured on former occasions. During the last two or three years, and especially during the last year, his condition gave increasing anxiety to his friends; the malady against which he had so long struggled seemed to be beating him at last; and we heard with sorrow rather than with surprise that the fierceness of the recent cold had conquered him. Settled for the winter at Bournemouth, and full of cheerful hopes for the coming summer, he succumbed to a sudden attack of inflammation of the lungs, and died on January 10th, 1891.

Science has lost a steady and fruitful worker, and many men of science have lost a friend and a helpmate whose place they feel no one else can fill. His wide knowledge of many branches of scientific inquiry, and his large acquaintance with scientific men, made the hours spent with him always profitable; his sympathy with art and literature, and that special knowledge of men and things which belongs only to the travelled man, made him welcome where science was unknown; while the brave patience with which he bore the many troubles of enfeebled health, his

unselfish thoughtfulness for interests other than his own, and a sense of humour which, when needed, led him to desert his usual staid demeanour for the merriment of the moment, endeared him to all his friends.

Angling and Microscopy.—A "microscopical evening" could, we should have thought, hardly be looked for at an angling society, but the following appears in 'Flood and Field' of the 29th November, 1890:—

"Gresham Angling Society.—There was a good attendance again on Tuesday, with Mr. Vail in the chair. This being a 'Microscopical Evening,' Dr. Brunton and Messrs. Norman, Parker, and Bentley showed a number of interesting subjects. Among other objects, Dr. Brunton exhibited a hank of so-called *silk*, sold by City houses for fly-tying, &c. Under the Microscope this proved to be nothing but *jute*, a fact which explains the frequent breaking away of large fish, and the consequent loss of tackle, temper, &c."

The Microscope and the McKinley Tariff.—Among numerous examples of the mischievous working of the McKinley tariff, the New York 'Nation' cites the instance of Microscopes. Since the branch of medical science known as bacteriology assumed so much prominence, these articles have risen in the United States from the rank of a toy to that of the most valuable and important of all medical instruments. Meanwhile a foolish legislature has been doing its best to make Microscopes artificially dear, and more and more difficult to procure. It was bad enough before the new tariff; but it is now worse. In spite of the touching appeals of eminent medical men, a Microscope which could be bought in Germany for 94 dollars now costs in America over 150 dollars. This is but one of many examples given of how the tariff is felt to be affecting the vital interests of the American people.

β. Technique.*

(1) Collecting Objects, including Culture Processes.

Experiments on Cultivation Media for Infusoria and Bacteria.†—In his experiments with anthrax, Dr. Hafkine obtained varying results; thus when cultivated in the aqueous humour of rabbits, guinea-pigs, or dogs, sometimes copious development occurred, but sometimes it altogether failed. When sown with typhoid bacillus the inhibitive action of the humour was very manifest, reducing the number of viable bacilli from 1880 to 7 in four hours. This result is explained by the author on the supposition that the bacilli, which had been cultivated for a long time in pepton bouillon, had not yet become acclimatized to the new medium. For by gradually adding an increasing amount of aqueous humour to the pepton bouillon, in twelve successive generations a strong increase in fresh humour was eventually obtained, indeed it was greater than in the bouillon. Control experiments made with bacilli obtained directly from a typhoid patient, behaved in a manner analogous to the artificial

* This subdivision contains (1) Collecting Objects, including Culture Processes; (2) Preparing Objects; (3) Cutting, including Imbedding and Microtomes; (4) Staining and Injecting; (5) Mounting, including slides, preservative fluids, &c.; (6) Miscellaneous.

† Annales de l'Institut Pasteur, iv. (1890) p. 363. See Centralbl. f. Bakteriol. u. Parasitenk., viii. (1890) p. 435.

cultivations in aqueous humour. The germicidal action of the humor aqueus is explained conformably to the ideas of Metschnikoff, with whom the author is working, as being entirely due to an imperfect adaptation to the new medium.

Silicic Acid as a Basis for Nutrient Media.*—Prof. W. Kühne employs silicic acid as a basis for nutritive media which will bear prolonged exposure to high temperatures, and which have the further advantages of resisting the action of organisms and reagents. To make the compound, the author mixes, with frequent shaking, three parts of commercial silicate of soda (sp. gr. 1·08) and one part dilute hydrochloric acid (HCl sp. gr. 1·17 one part, and water two parts). The mixture is then freed, in a dialyser, from free acid and from sodium chloride, by suspending the dialyser for four days in a stream of running water. The pure solution is then condensed to a specific gravity of 1·02 by heating it in a platinum vessel. In this condition it contains 3·4 per cent. pure acid, is as thin as water, can be boiled, is miscible with alcohol, and only coagulates on addition of neutral salts. The nutrient addendum employed by the author was meat-extract: a piece of Liebig's extract about the size of a bean is dissolved in 22 ccm. of water, and of this solution 0·5 to 1 ccm. is added to 4 ccm. of silicic acid. If it be desired to set it quickly some cooking salt must be added. Thus obtained the jelly is of the proper consistence, transparent as glass, and scarcely coloured by the meat-extract. It bears the addition of sugar, glycerin, &c.

Pure Cultivations of Green Unicellular Algæ.†—M. W. Beyerinck has obtained pure cultivations from two species, *Chlorococcum protogenitum* Rabenh. and *Rhaphidium naviculare* sp. n., which are frequent in stagnating water near Delft. The author succeeded in getting rid of the numerous water bacteria by the following method:—Ditch water was boiled up with 10 per cent. gelatin, and before setting was mixed with a drop of the water coloured green by the algæ. In this mixture only those bacteria which liquefy gelatin could develope. The number of such colonies may be few enough not to liquefy the whole of the gelatin in two or three weeks. With a hand-lens the algar colonies may then be recognized as dark green points. These can then be distributed to fresh gelatin and so pure cultivations obtained. *Rhaphidium* was found to excrete a trypsinoid ferment which liquefied gelatin. It multiplied by fission. *Chlorococcum* does not liquefy gelatin, and was cultivated on seven different nutritive media with a neutral or slightly acid reaction. Development in all the seven media proceeded at about the same pace, but the colour of stroke cultivations was very different.

In sterilized ditch water with 1 per cent. gelatin previously liquefied by pancreas, the growth advances well, and after three or four weeks there results a yellow fluid with a dark green sediment of *Chlorococcum*.

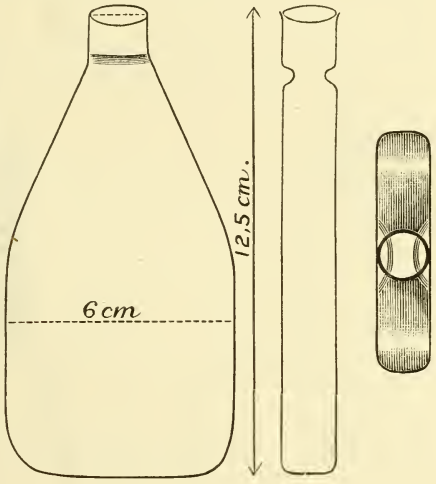
* Zeitschr. f. Biologie, xxvii. n.s. ix. (1890) No. 1. Cf. Centralbl. f. Bakteriol. u. Parasitenk., viii. (1890) pp. 410–11.

† 'Aanteekeningen van het verhandelde in de sectie-vergaderingen van het Provinciaal Utrechtsch Genootschap voor kunsten en wetenschappen gehouden den 25 Juni 1889,' pp. 35–52. Cf. Centralbl. f. Bakteriol. u. Parasitenk., viii. (1890) pp. 460–2.

By mixing this sediment with liquefied gelatin, and pouring it into test-tubes, or flattening it out between two glass plates, an equally coloured green cast or plate is obtained which serves excellently for studying the action of light on chlorophyll and the excretion of oxygen.

Flat Flask for cultivating Micro-organisms.*—Dr. J. Petruschky has devised a convenient apparatus for cultivating micro-organisms on the plate or surface principle. It is merely a flat flask, and is made in two shapes. Shape A is made of thin lamp-glass, and the B shape of thick or plate glass. Both have pretty much the same form; that is, they are flat and somewhat triangular, or rather like a flat worm. Their general aspect is seen from the illustrations, which give a front and side view, and also the view down the neck when looked at from above. There is a slight difference in the measurements; those of the A pattern being, height 10–11 cm., breadth 5½–6 cm., width (same measurement as neck) about 1½ cm. In the neck there is a circular indentation. The measurements of the B pattern are, height 12·5 cm., breadth 6 cm., width (same as neck) 2 cm. In this pattern the indentation is confined to the broad side of the neck.

Fig. 11.



The A pattern is more suitable for delicate work, such as the differentiation of typhoid colonies, while the B form suffices for isolation, enumeration, and inoculation purposes.

These flat flasks are specially adapted for the bacteriological examination of water, and for the cultivation of anaerobic microbes in hydrogen.

Apparatus for filtering perfectly clear Agar.†—Dr. J. Karlinski has invented an apparatus for filtering agar, and though it agrees with that devised by Jakobi, differs from the latter in that its intention is, besides obtaining a perfectly clear solution, to prevent the too quick cooling and setting of the medium.

The apparatus, seen in section, fig. 12, consists of a tin vessel *a*, the upper end of which is closed with a perforated caoutchouc plug, and its bottom ends in a tube fitted with a stopcock.

The vessel *a* is surrounded by the vessel *b*, made of similar material, and from near the bottom passes out a short closed pipe. The space *b*

* Centralbl. f. Bakteriol. u. Parasitenk., viii. (1890) pp. 609–14 (3 figs.).
† T. c., pp. 643–5 (2 figs.).

is intended to contain hot water, which is heated by means of a spirit-lamp. In the vessel *a* is placed a layer of cotton-wool 10 cm. thick, and this is, before using, damped with hot water.

The agar solution, made according to Jakobi's formula, is then poured into *a*, and the aperture closed with the caoutchouc plug, to which is attached the hand-bellows. The agar solution is thus made

Fig. 12.

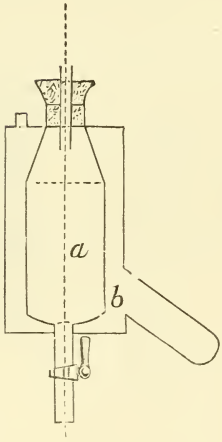
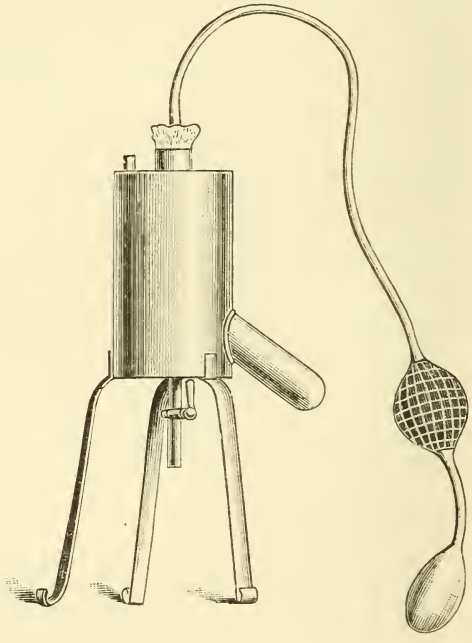


Fig. 13.



to run out through the pipe at the bottom by means of compressed air, and is allowed to flow into sterilized vessels. The hot-water jacket prevents the agar from cooling too quickly, so that many test-tubes may be filled very easily. Fig. 13 gives an outside view of the whole apparatus.

Pure Cultivations of Gonococcus.*—Herren H. von Schrötter and F. Winkler recommend the albumen of plover's eggs as an excellent nutritive medium for easily obtaining pure cultivations of Neisser's gonococcus. The medium is prepared after the method of Dal Pozzo.†

* Mittheil. aus d. Wiener Embryol. Institut, 1890, pp. 29–34.

† See this Journal, 1888, p. 1037.

(2) Preparing Objects.

Methods for the Preservation of Marine Organisms employed at the Naples Zoological Station.*—Prof. Playfair McMurrich writes, "Unfortunately for our students, especially those living inland and depending largely for their knowledge of marine forms upon dried or preserved specimens in museums, the old-fashioned methods of throwing any material which the collector may find into a jar of alcohol without further attention, or else drying it in the sun, are still almost the only ones made use of for the preservation of museum specimens. The result is that the majority of forms which the student has for study are either dried skeletons, or shrivelled up monstrosities giving no idea whatever of the actual appearance of the creatures supposed to be represented by them. How many college museums possess a specimen of coral showing in any recognizable form the polyps by which the skeleton coral was formed? Or how many have even a satisfactorily prepared Lamellibranch?

There are, however, in this country, a few collections which show a marvellous improvement in their manner of preparation, and which have been purchased from the Naples Zoological Station, whose conservator, Salvator Lo Bianco, has for several years been devoting himself to the discovery of the best methods for the preservation of the form and colour of the marine animals occurring in the Mediterranean. Until the present, however, his discoveries have not been made common property, except in the few cases where most successful methods for preserving certain forms have been published in connection with accounts of their structure. The last number of the Naples 'Mittheilungen,'† however, contains a full description, by Lo Bianco, of the methods found most successful for the preservation of the various forms which occur at Naples, and which are undoubtedly applicable to the similar forms found upon our own coast. An abstract of these methods is given in the following pages, in the hope that they may be found useful by the museum curators of this country, and that their application may result in the much-needed improvement of the appearance of the specimens found in the majority of the college museums.

It must be fully understood, however, that much depends upon the skill of the preparator, and that want of care and patience will frequently counteract all the advantages to be derived from a good method. All who have had the opportunity of examining specimens prepared by Lo Bianco can appreciate readily the great advantages which may result from the careful application of his methods, and can perceive how greatly we are indebted to him and to Prof. Dohrn for their publication.

Alcohol is, of course, indispensable as preservative fluid, but certain precautions are necessary in its use. Except in a very few cases it is unnecessary to use it in its full strength, 70 per cent. being quite sufficient for preservation, and producing much less contraction and fragility in delicate organisms. Strong alcohol should be reduced with distilled water to the desired strength, ordinary spring water frequently contain-

* Amer. Natural., xxiv. (1890) pp. 856–65.

† See Mittheil. Zool. Stat. Neapel, ix. (1890) pp. 435–74.

ing a sufficient amount of carbonate of lime and other substances in solution to give a cloudy precipitate, after a time, which may effectually destroy the appearance of a specimen.

Furthermore, delicate organisms should first be placed in weak alcohol (35 to 50 per cent.) for from two to six hours, the changing of the fluids being effected by a siphon, a small quantity of the weak alcohol being withdrawn and stronger added, until finally the desired strength is obtained. With delicate gelatinous structures the increase in the strength of the alcohol should be as gradual as possible. In many cases it is necessary to use a hardening or fixing reagent before the final consignment to alcohol, which is principally useful as a preservative. The most fixing reagents, according to Lo Bianco, are the following :—

Chromic acid.—1 per cent. in fresh water. Objects should not remain in the fluid longer than is necessary to fix them, as they are apt to become brittle. Subsequently they should be well washed with distilled water to prevent the formation of a precipitate when placed in alcohol, and also to prevent their taking on too green a tinge from the reduction of the acid.

Acetic acid, concentrated, kills rapidly contractile animals, but must be used with caution, as it produces a softening of the tissues if they are subjected for too long a time to its action.

Osmic acid, 1 per cent. solution, hardens gelatinous forms well, and preserves their transparency, but its prolonged action renders the objects brittle and gives a dark brown tint. Objects hardened in it should be well washed in distillled water before being placed in alcohol.

Lactic acid.—1 part to 1000 parts sea-water fixes larvæ and gelatinous forms well.

Corrosive sublimate.—Saturated solution in fresh or sea-water; may be used either hot or cold. It acts quickly, and preserves admirably for histological purposes. It is especially good combined with copper sulphate, acetic acid, or chromic acid. Objects hardened in it should be subsequently well washed in distilled water and in iodized alcohol (the recipe for which is given below), to remove all traces of the sublimate, which in alcohol crystallizes out in the tissues of the organisms and so injures the preparation.

Bichromate of potassium.—5 per cent. solution in distilled water hardens gelatinous organisms slowly, without rendering them fragile. It gives, however, a precipitate in alcohol, and discolours the specimen. The discoloration, however, may be removed by adding to the alcohol a few drops of concentrated sulphuric acid.

Copper sulphate.—5 per cent, or 10 per cent. solution in distilled water, used either alone or in combination with corrosive sublimate, kills larvæ and delicate animals without distortion. The objects should be subsequently repeatedly washed with water to remove all traces of the salt, otherwise crystals will form when the object is placed in alcohol.

Various combinations of these reagents are especially useful, and some of those most serviceable are given here :—

Alcohol and chromic acid.—70 per cent. alcohol, 1 per cent. chromic acid, equal parts.

Alcohol and hydrochloric acid.—50 per cent. alcohol, 100 ccm.; Hydrochloric acid, concentrated, 5 ccm.

Iodized alcohol.—35 per cent. or 70 per cent. alcohol, 100 ccm.; Tincture of iodine, 2·5 ccm.

Chrom-acetic acid, No. 1.—1 per cent. chromic acid, 100 ccm.; Concentrated acetic acid, 5 ccm.

Chrom-acetic acid, No. 2.—Concentrated acetic acid, 100 ccm.; 1 per cent. chromic acid, 10 ccm.

Chrom-osmic acid.—1 per cent. chromic acid, 100 ccm.; 1 per cent. osmic acid, 2 ccm.

Chrom-picric acid.—1 per cent. chromic acid, Kleinenberg's picro-sulphuric acid, equal parts.

Copper sulphate and corrosive sublimate.—10 per cent. solution of copper sulphate, 100 ccm.; saturated solution of corrosive sublimate, 10 ccm.

Potassium bichromate and osmic acid.—5 per cent. solution of potassium bichromate, 100 ccm.; 1 per cent. osmic acid, 2 ccm.

Corrosive sublimate and acetic acid.—Saturated solution of corrosive sublimate, 100 ccm.; concentrated acetic acid, 50 ccm.

Corrosive sublimate and chromic acid.—Saturated solution of chromic sublimate, 100 ccm.; 1 per cent. chromic acid, 50 ccm.

Frequently great difficulty is experienced in killing an animal without producing a considerable amount of contraction, and in the case of elongated forms, such as Nemerteans and other worms, without causing them to coil up or become twisted, To avoid this, it is expedient to narcotize the animals before killing them, and for this purpose Lo Bianco recommends immersion in weak alcohol. He uses generally a mixture of sea-water 100 ccm. and absolute alcohol 5 ccm. In other cases 70 per cent. alcohol may be carefully poured upon water in which the specimen lies, so that it forms a layer at the surface. It will gradually mix with the subjacent water, and in the course of a few hours will narcotize the animal, so that it may be treated with fixing reagents without fear of contraction.

Chloral hydrate, 1 to two parts sea-water, is also efficient as a narcotizing agent, and has the advantage of allowing a recovery of the animal, if there should be necessity for it, by placing it in fresh sea-water. For some sea-anemones tobacco smoke is useful, the smoke being conducted by a V-shaped tube into a bell-jar covering the vessel of sea-water in which is the anemone. Certain of these reagents will prove most satisfactory with some animals, others with others. Lo Bianco details the best method for treating the various forms in a second portion of his paper, and an account of some of his methods of procedure, so far as they concern forms which resemble those found upon our coast, may now be presented.

Sponges.—Direct immersion in 70 per cent. alcohol, with subsequent renewal of the fluid, is recommended for the majority of forms. To avoid contraction in the case of the Halisarcidæ, they should be left for half an hour in 1 per cent chromic acid, or in concentrated solution of corrosive sublimate for fifteen minutes. To prepare dried specimens the sponges should be washed in fresh water for a few hours, and then allowed to remain in ordinary alcohol for a day, after which they may be dried in the sun.

Anthozoa.—The first care must be to place the forms belonging to this group in fresh salt water, to allow them to expand, a result which may not be obtained until the following day in some cases. Alcyonarians should be killed with chrom-acetic solution No. 2, withdrawing the water in which they lie, until there is left just enough to cover them, and then adding a volume of the chrom-acetic solution double that of the sea-water. The animals should be removed from this mixture the moment they are killed, since the acid will quickly attack the calcareous spicules, which are important for the identification of the Alcyonaria, and placed in 35 per cent. or 50 per cent. alcohol, it being well to inject the alcohol into the mouths of the polyps to keep them freely expanded. The preparation should finally be preserved in 70 per cent. alcohol.

Regarding the Actinians no definite rule for preservation can be given. Much of the success of the preparation depends on the form employed, some species contracting much less readily and less perfectly than others. Some may be killed in a fair condition by pouring over them boiling corrosive sublimate, and then, before consigning them to alcohol, treating for a few minutes with one-half per cent. chromic acid. This method may be employed with small forms such as *Aiptasia*. Narcotization may be tried with others. For this purpose, remove from the vessel in which the animals are contained, two-thirds of sea-water, and replace it with a 2 per cent. solution of chloral hydrate. After a few minutes the fluid is again removed, and cold concentrated sublimate solution is poured in. Tobacco smoke in some cases, as with *Adamsia*, will act satisfactorily, if followed with vapour of chloroform for two to three hours, after which the animals may be killed in chrom-acetic solution No. 2, and hardened in one-half per cent. chromic acid.

Edwardsia may be narcotized by gradually adding 70 per cent. alcohol to the sea-water in which they are, and subsequently may be killed with hot corrosive sublimate.

Cerianthus should be killed with concentrated acetic acid, placing it as soon as possible in weak alcohol, in which it should be suspended, so that the tentacles may float freely—if necessary, disentangling them.

Corals should be allowed to expand fully, and should then be killed with boiling solution of corrosive sublimate and acetic acid used in volume equal to that of sea-water containing the coral. The colony should then be transferred to 35 per cent. alcohol, some of this fluid being injected into the mouth of each polyp. The injection should be repeated at every change of the alcohol, and the specimens should be preserved in 70 per cent. alcohol, after washing them well in iodized alcohol.

Hydromedusæ.—For the hydroid colonies the best fixing reagent is hot corrosive sublimate. The smaller Tubularian medusæ should be killed either in the mixture of corrosive sublimate and acetic acid, or in Kleinenberg's picrosulphuric acid. Larger forms may be fixed with concentrated acetic acid, and then allowed to fall imto a tube containing the alcohol and chromic acid mixture, in which they are gently agitated and allowed to remain for fifteen minutes, after which they should be transferred to 35 per cent. alcohol, and gradually carried to 70 per cent.

Small Campanularian medusæ, e. g. *Eucope* and *Obelia*, may be killed in the mixture of copper sulphate and corrosive sublimate. *Æquorea*

should be killed with concentrated acetic acid, and immediately transferred to chrom-osmic mixture for fifteen to thirty minutes. The same method answers for *Cunina*, while *Liriope* should be treated at once with chrom-osmic from five to twenty minutes.

Scyphomedusæ are the best fixed with 1 per cent. osmic acid, to the action of which they are subjected until they assume a pale brown tint. They should then be thoroughly washed with fresh water before being placed in 35 per cent. alcohol, and should be finally preserved in 70 per cent.

Siphonophores.—The forms of this group should be preserved soon after capture, and specimens in good condition should be selected.

Agalma and similar forms should be killed in the mixture of copper sulphate and sublimate, which should be used in volume equal to or double that of the sea-water in which the animal floats. The mixture should be poured in rapidly, and not over the animal. When killed, the specimen should be carefully lifted upon a large horn spatula, and transferred to 35 per cent. alcohol for a few hours, and then placed in 70 per cent. It is recommended to preserve the animals in tubes just large enough to contain the specimens, and placed within a second larger tube. In this way evaporation of the alcohol is prevented, and also injury of the specimen from movements of liquid is avoided.

Physalia should be placed in a cylinder filled with sea-water, the animal being lifted by the pneumatophore. When well expanded, it is killed by pouring over it the sublimate and acetic acid mixture (one-quarter the volume of the sea-water), and when dead, is transferred to a cylinder containing one-half per cent. chromic acid, and then after twenty minutes to 50 per cent. alcohol, and finally to 70 per cent.

Velella may be killed with chrom-picric or sublimate and chromic acid mixture, and after a few minutes should be transferred to weak alcohol. *Porpita* may be fixed by dropping Kleinenberg's picro-sulphuric acid into the vessel in which it is contained, and when the blue colour commences to change to red it should be transferred to Kleinenberg's fluid, and after fifteen minutes to weak alcohol.

Diphyes may be killed expanded by hot corrosive sublimate.

Ctenophora may be killed by throwing them into the chrom-osmic mixture, where they should remain for fifteen to sixteen minutes, according to the size, and then gradually passing them through alcohol to 70 per cent. A mixture composed of pyroligneous acid, concentrated, 1 vol.; corrosive sublimate solution, 2 vol.; one-half per cent. chromic acid, 1 vol., is also recommended as a fixative.

Echinodermata.—Starfish may be prepared with the ambulacral feet in full distension by allowing them to die in 20 to 30 per cent. alcohol. Echinoids should be placed in a small quantity of water, and killed with chrom-acetic mixture No. 2, being removed from it as quickly as possible, as the acid corrodes the test. To preserve the internal parts it is necessary to make two opposite openings in the test, so that the alcohol may penetrate the interior readily.

Holothurians, such as *Thyone* and *Cucumaria*, after the tentacles are fully expanded, should be seized a little below the bases of the tentacles by forceps, using a slight pressure, and the anterior portion of the body should then be immersed in concentrated acetic acid. Alcohol (90 per

cent.) should then be injected into the mouth, and the specimens placed in 70 per cent. alcohol. The injection should be repeated each time the alcohol is changed.

Synapta should be fixed by immersion in a tube containing a mixture of equal parts of sea-water and ether (or chloroform), where they remain completely expanded. They should then be washed for a short time in fresh water, and passed into alcohol, taking care to increase the strength of this very gradually.

Vermes.—Cestodes, Trematodes, Turbellaria, as well as Nemathelminths, are most satisfactorily killed with corrosive sublimate, either cold or hot. *Sagitta*, however, succeeds best in copper sulphate and sublimate or chrom-osmic mixture.

Nemerteans should be narcotized in a solution of chloral hydrate in sea-water 1 per cent., where they should remain for six to twelve hours. They are then to be hardened in alcohol. Gephyreans may be narcotized with 1 per cent. solution of chloral hydrate in sea-water, or in alcoholized sea-water, three to six hours; or may be killed at once in one-half per cent. chromic acid, which last method may be also applied to Hirudinea.

Chætopods are best narcotized in sea-water containing 5 per cent. of absolute alcohol, or by adding gradually to the surface of the sea-water in which they are contained a mixture of glycerin 1 part, 70 per cent. alcohol 2 parts, and sea-water 2 parts, hardening them subsequently in alcohol. *Chætopterus* is best killed with 1 per cent. chromic acid, in which they should remain for half an hour; while the Hermellidæ, Aphroditidæ, and the Eunicinæ may be killed in cold corrosive sublimate. Some of these, such as *Diopatra*, may, however, be narcotized in alcoholized sea-water.

Serpulidæ, before treatment with corrosive sublimate, should be narcotized in 1 per cent. chloral hydrate, which causes them to protrude wholly or partly from their tubes.

Crustacea.—Cladocera, Copepods, and Schizopods may be killed in corrosive sublimate dissolved in sea-water. Ostracods may be thrown at once into 70 per cent. alcohol. Cirripeds die expanded in 35 per cent. alcohol, and if some specimens contract it is easy to draw out the cirri with forceps. Amphipods and Isopods may pass directly into 70 per cent. alcohol, except the Bopyrids and Entoniscids, which should be killed in the mixture of equal parts of 90 per cent. alcohol and sublimate solution.

To avoid the casting-off of the appendages of the Decapods they should be allowed to die in fresh water, care being taken not to allow them to remain in it longer than is necessary, as it causes a distortion of the membranous appendages.

Pycnogonids will die in one-half per cent. chromic acid, with the appendages fully extended.

Mollusca.—Lamellibranchs, Prosobranchs, and Heteropods should be narcotized in alcoholized sea-water. To avoid the closure of the valves of Lamellibranchs on immersion in 70 per cent. alcohol, little plugs of wood should be placed between the margins of the valves. The same result may be effected in the case of Prosobranchs by tying the internal edge of the operculum to the shell.

Of the Opisthobranchs the Æolidæ may be the best preserved by

pouring over them concentrated acetic acid in volumes equal to or double that of the sea-water containing them. Dorids should first be narcotized by gradually adding 70 per cent. alcohol to their sea-water, and then killed with concentrated acetic acid or boiling sublimate. The larger forms may be killed in 1 to 5 per cent. chromic acid.

Pteropods are preserved well in Perenyi's fluid for 15 minutes, whence they are passed to 50 per cent. alcohol. Gymnosomatous forms should be first narcotized with 1 per cent. chloral hydrate, and then killed in acetic acid or sublimate.

Decapod Cephalopods may be fixed directly in 70 per cent. alcohol, making an opening on the ventral surface to allow the alcohol to reach the internal parts.

Bryozoa.—The genera *Pedicellina* and *Loxosoma* may be left for an hour in 1 per cent. chloral hydrate, and then killed with cold corrosive sublimate, washing them immediately afterwards. Some species of *Bugula* give good results when the expanded animals are suddenly killed by pouring over them hot corrosive sublimate. With other forms it is sometimes possible to preserve them well expanded by adding 70 per cent. alcohol gradually to the surface of the water in which they are, or by narcotizing first in weak chloral hydrate or in alcoholized sea-water. The results are, however, uncertain, and depend largely on the skill of the preparator. Brachiopoda may be treated in the same manner as Lamellibranchs.

Tunicates.—*Clavellina*, *Perophora*, and *Molgula* may be killed with the orifices expanded by immersing them in 1 per cent. chloral hydrate for 6 to 12 hours. They should then be killed in chromic-acetic mixture No. 2, and quickly transferred to 1 per cent. chromic acid, injecting some of the fluid into the body. After half an hour they should be transferred to 35 per cent. alcohol, the injection being repeated, and finally to 70 per cent. Other simple forms may be treated in the same manner, or may require the 2 per cent. solution of chloral hydrate, or may be killed by pouring a little 1 per cent. chromic acid on the surface of the water in which they are, subsequently hardening in 1 per cent. chromic acid. The method recommended for *Perophora* may be employed for compound Ascidians, using, however, corrosive sublimate instead of the chrom-acetic mixture.

Salpæ vary considerably in consistency, according to the species, and different methods are consequently required. The denser forms, such as *S. zonaria*, should be placed in a mixture of 100 ccm. fresh water and 10 ccm. concentrated acetic acid, where they should remain for 15 minutes. They should then be washed in fresh water for 10 minutes, and pass gradually into alcohol. Less dense forms such as *S. democratica mucronata*, may be fixed in chrom-acetic mixture No. 1, and then passed directly into fresh alcohol; while the soft forms such as *S. pinnata* and *maxima*, should be placed in chrom-osmic mixture for 15 to 60 minutes, then washed in fresh water, and transferred to weak alcohol.

Fishes.—*Amphioxus* will die with the buccal cirri distended in sea-water alcoholized to 10 per cent. They should then be transferred to 50 per cent. alcohol, and gradually to 70 per cent.

Other forms may be preserved in alcohol (70 per cent.), taking care to make a ventral incision, and also to inject the alcohol and renew it

frequently at first. If it is wished to preserve some of the larger Selachians for some months in order to prepare at leisure the skeleton, the intestines should be removed, and the animals placed in a 10 per cent. solution of salt.

Elasmobranch embryos may be fixed in corrosive sublimate, leaving them in the solution for 5 to 15 minutes, afterwards washing well in iodized alcohol. Embryos of *Torpedo* with the yolk were preserved by immersing them in a mixture of equal parts of 1 per cent. chromic acid and corrosive sublimate for 15 minutes, and then transferring to alcohol. Transparent fish-eggs may be preserved for the purpose of demonstration by subjecting them for a few minutes to the action of the alcohol and hydrochloric acid mixture, and then transferring them to pure alcohol.

Some Hints on the Preparation of Delicate Organisms for the Microscope.*—Mr. E. Lovett observes that such organisms as the ova of Mollusca, Crustacea, fishes, &c., are often of such a nature as to be very difficult of permanent preservation, but he has succeeded in overcoming the difficulty satisfactorily by means of a fluid, the density of which he modifies in accordance with the organism about to be mounted. The fluid was composed as follows:—Three parts pure alcohol, two parts pure glycerin, and one part distilled water. This strength was suitable for young crustaceans, the ova of the fishes, and for the tougher ova-sacs of the Mollusca. For the ova of crustaceans and insects, and for those of very small fishes, one or two parts more of distilled water may be added; whilst for such exceedingly delicate substances as the ova of the nudibranchiate Mollusca, zoophytes extended from their capsules, and for various delicate fresh-water forms, a weaker formula than this is necessary; but as practice is the best instructor, he recommends students to be guided by what they find to be the best proportions.

This fluid should be put into small glass tubes, with corks bearing numbers corresponding to those in a note-book, so that full details of the contents may be recorded. These tubes should be taken down to the shore by the collector, and the organisms should be placed therein alive, direct from the sea. The length of time required for the preservation of the object by the fluid varies, according to the organism, from a week to a year, but some of Mr. Lovett's best preparations had been soaking, before being mounted, for five or seven years; and as a proof of the value of the preservative fluid, he cites the mucus-like ova mass of an *Eolis*, which was in quite its natural condition, although eight years of age as a micro-slide. The cement used by Mr. Lovett for fixing cells for this fluid, for fixing the cover-glasses to the cell-wall, or for covering sunk cells, is composed of equal parts of red lead, white lead, and brown litharge, pounded to a powder and kept dry. When wanted for use, a little is mixed with japanner's gold size as thick as required, and it must be used with great care to insure success; but in this case also practice is the best way to satisfactory results.

Improved Method of preparing Ascidian Ova.†—Dr. T. H. Morgan found that the ordinary methods of preparation do not show the boundaries of the cells of the follicle in sections of young ova. He made,

* Trans. Croydon Micr. and Nat. Hist. Club, 1889–90, pp. 203–4.
† Journal of Morphology, iv. (1890) p. 198.

therefore, various experiments, and found the following method satisfactory. The fresh ovaries were teased apart in very dilute osmic acid, washed in distilled water, and placed in a 1 per cent. solution of silver nitrate, where they remained for half an hour; they were then put into acetic acid for the same length of time, and placed in the sunlight. On examination under the Microscope the cell-boundaries were distinctly seen.

Simple Method of examining living Infusoria.*—Herr J. Eismond has discovered a method of slowing those rapid movements of Infusoria which make the examination of these objects during life so difficult. The method is based on that of crystallographers, who retard the formation of crystals by the addition of a colloidal material. He added a drop of thick watery solution of cherry-gum, and obtained the desired effect. In a very short time the Ciliata were seen to be imprisoned, with all their cilia moving actively, but effecting no change in position. All the vital processes can be most satisfactorily observed in Infusoria so treated, and a certain amount of locomotion can be allowed by using a less dense solution. Small Crustacea, Worms and Flagellata, and other marine animals, may be well studied by this method. It may be added that gum-arabic and other fixing materials are useless.

New Method for demonstrating Tubercle Bacilli in Sputum.†—Dr. E. Czaplewski recommends the following method which he says gives ideal pictures in about three minutes of tubercle bacilli in sputum. Three solutions are required :—(1) The Ziehl-Neelsen carbolic-fuchsin. (2) Saturated alcoholic solution of yellow fluorescin to which methylen-blue is added to excess. (3) Saturated alcoholic solution of methylen-blue.

A very thin layer of sputum must be fixed on the cover-glass in the usual manner. On the cover-glass held in a pair of forceps, sputum side upwards, is then let drop sufficient of the fuchsin solution to form a complete layer. It is then held over the flame of a spirit-lamp until it vaporizes or begins to boil. The fuchsin is then run off and the cover-glass waved to and fro in the fluorescin solution six to ten times, and after this in the methylen-blue solution ten to twelve times. The cover-glass is next quickly washed in pure water and then at once laid with the prepared surface upon a clean slide. The superfluous water is then expressed by means of a piece of blotting-paper placed on the top, and any deposit of pigment removed with a moist cloth. Finally, a drop of cedar oil is laid on the back. The preparation is then ready for examination. Hence it will be seen that the organisms are observed in water, but the preparation may of course be mounted in the usual manner.

Method for Differential Diagnosis of Bacilli of Typhoid (Eberth).‡—The procedure consists in a modification by J. Gasser of Noeggerath's method for recognizing the typhoid bacillus. To a test-tube full of nutrient agar twenty drops of a saturated aqueous solution of fuchsin are added, the mixture sterilized and poured into a Petri's

* Zool. Anzeig., xiii. (1890) pp. 723–4.

† Centralbl. f. Bacteriol. u. Parasitenk., viii. (1890) pp. 685–94.

‡ La Semaine Méd., 1890, No. 31. Cf. Bakteriol. u. Parasitenk., viii. (1890) p. 411.

capsule. When set the surface is scratched with the bacillus and then incubated at 37°. In four hours the cultivation has developed, the agar round about it being decolorized. The whole plate has lost its colour in six to eight days, but the cultivation itself is quite red.

Control experiments with numerous other micro-organisms showed that typhus bacillus and *B. coli communis* were the only two which decolorized the medium. It is said that the two may be distinguished by the fact that *B. coli comm.* does not exceed the inoculation track, while typhus bacillus forms a broader strip with irregular margins.

New Criterion for distinguishing between Bacillus Choleræ Asiaticæ and the Finkler-Prior Bacillus.*—If these two bacilli, say Herren O. von Hovorka and F. Winkler, be cultivated on plover's egg albumen they may easily be distinguished. The Finkler-Prior bacillus rapidly liquefies, and imparts a yellow colour to the medium, while Koch's comma bacillus neither liquefies nor stains it. This difference is clearly distinguishable in the first six days of the cultivation.

Reference Tables for Microscopical Work.†—Professor A. B. Aubert has compiled the following tables which have been in great part translated and adapted from Dr. Behrens' 'Tabellen zum Gebrauch bei Mikroskopischen Arbeiten.' They address themselves especially to workers in the various departments of microscopy where such aids to the memory may be helpful in everyday work. The methods given are such as have received the approval of many of the best workers at home and abroad. A glance at the tables will generally give all the information necessary to any one fairly familiar with micro-manipulation, and while they do not aim at replacing the larger and more complete works, it is hoped that they will prove useful on the work-table of microscopists generally.

Preservative and Mounting Media :—Alcohol-glycerin.—Glycerin, 1 part; alcohol (96 per cent.), 1 part; water, 1 part. Specially recommended for plants, entire or in parts.

Canada balsam in alcohol, chloroform, benzol, turpentine, xylol.—The balsam is hardened by low heat until brittle when cold, broken up or pulverized, dissolved in the solvents, filtered through paper, and evaporated until of the thickness of syrup.

Boroglyceride.—Dissolve as much boracic acid in warm glycerin as possible. The solution is thick when cold; use for mounting some animal or plant preparations in the same way as balsam.

Canada balsam :—The thick balsam is heated, and the mounting done on the warm table; the object must first be soaked in absolute alcohol, then in oil of cloves.

Glycerin and carbolic acid :—Glycerin, 100 grm.; absolute alcohol, 50 grm.; water, 50 grm.; carbolic acid, 3 grm. For plant sections, &c.

Chloride of calcium concentrated, or 33, 25, 12 per cent. For vegetable preparations, &c.

Dammar :—Dissolve gum dammar in equal parts of benzol and turpentine; the solution is filtered and evaporated to syrupy thickness.

* Mittheil. aus d. Embryol. Institute der K. K. Univ. Wien, 1890, pp. 10–14.

† Micr. Bull. and Sci. News, vii. (1890) pp. 35–6.

Farrant's medium:—Gum arabic, 1 ounce; glycerin, 1 ounce; water, 1 ounce; arsenious oxide, 1½ grains. Dissolve the oxide in water, then the gum, without heat; when entirely dissolved add the glycerin, take care not to form bubbles; can be filtered through fine flannel. Specially recommended for delicate plant or animal tissues.

Glycerin:—Concentrated or diluted with water, to which may be added a few drops of acetic or carbolic acid. For vegetable and animal preparations.

Glycerin-jelly:—Glycerin, 120 grm.; water, 60 grm.; gelatin, 30 grm. Dissolve the gelatin in warm water, add the glycerin, filter, if necessary, through flannel. All forms of glycerin-jelly must be used warm. For vegetable and animal tissues.

Deane's medium:—Similar to glycerin-jelly but with the addition of honey and a small quantity of alcohol. Used in place of glycerin-jelly.

Glycerin-salicylic vinegar:—Glycerin, 1 vol.; water, 4 vol; salicylic vinegar, 0·1 vol. For Infusoria.

Glycerin-salicylic vinegar for larvæ, *Hydra*, Nematodes, &c.:—Glycerin, 1 vol.; water, 2 vol.; salicylic vinegar, 0·1 vol. Salicylic vinegar is made by dissolving 1 part salicylic acid in 100 parts pyroligneous acid, sp. gr. 1·04.

Goadby's medium:—Corrosive sublimate, 0·25 grm.; alum, 60 grm.; boiling water, 2300 grm.

(3) Cutting, including Imbedding and Microtomes.

Imbedding Seeds by the Paraffin Method.*—Mr. W. W. Rowlee writes:—"The modifications that may be made of the paraffin method of imbedding objects for sectioning are very many. There is always, however, some danger of shrinking delicate and very soft plant tissue. This is due to the use of heat in the process of infiltration; and probably some of the non-heat-employing methods will be found preferable where such delicate tissue is to be imbedded. But for objects that will withstand this process of infiltration, the paraffin method has many advantages over others. Imbedded in paraffin, objects are held firmly, and may be preserved as long as desired without further attention.

For imbedding mature seeds I have found nothing equal to paraffin. The texture of the seed is often very dense, and offers much resistance to the knife. For this reason I found it better to use the harder grade of paraffin. A second serious difficulty that was met with in imbedding seeds was the fact that there was little, if any tissue connecting the embryo † with the seed-coats. Thus it would happen too often that just as the sections were being taken through the middle of the seed—and the most valuable ones are those near the centre—the embryo would leave the coats and the whole series would be spoiled. The inner surface of the inner coat in many seeds is highly polished, and as soon as there is nothing to retain the embryo but its adhesion to the coat, it will loosen. The paraffin does not hold the two together as would be expected. It was suggested that, in order to soften the tissue

* Amer. Mon. Micr. Journ., xi. (1890) pp. 228-30.

† The term "embryo" is used here where on some accounts it would be better to use the word "nucleus." The embryo is often but a very small part of the substance contained within the seed-coats.

and thereby make it more susceptible of infiltration, it would be well to thoroughly soak the seeds in water before hardening in alcohol. This was tried, and there was a great improvement in the results. Fewer of the sections went to pieces after they were transferred to the slide, and the parts of the seed kept their respective positions much better.

In order to study the microscopic structure of seeds, much more satisfactory results can be obtained if the sections are kept in series. It is often necessary to have two or more successive sections before a correct idea of the seed can be obtained.

The method is a modification of the one used and taught in the histological laboratories of Cornell University. In its practical application it is as follows:—In choosing seeds to section, great care is taken to get those which are well filled. This precaution is especially important, as many seeds, for various reasons, never develope more than the coats or the enveloping ovary coats. If a seed has a straight embryo, or even a bent or curved one, it is better to determine by dissection just how the parts of the embryo are arranged with reference to the external parts of the seed. Thus, the seeds of *Helianthus tuberosus* are flattened, and slightly wedge-shaped. The embryo within is straight, and the upper or inner surface of the cotyledons lie in a plane parallel to the plane in which the seed is flattened. Moreover, the cotyledons are in the upper broader end of the seed. Where the seed has no external character, as in a *Eupatorium*, by which the position of its internal parts may be located, one has either to take the chances of getting the sections in the right plane, or open the coats enough to see how the parts are arranged, and then mark the seed in some way. Having selected a well-filled seed, I next put them in water at the ordinary temperature of the laboratory from 24 to 36 hours. From the water they are transferred to weak alcohol (40 per cent.), and gradually hardened by transferring to stronger until they are in 95 per cent. alcohol. Schultze's apparatus may be used to advantage in hardening. Next transfer to equal parts of alcohol and chloroform for from 4 to 8 hours, the time depending on the size of the seeds. Then in pure chloroform for the same length of time. Then for 24 hours into chloroform with as much paraffin in it as it will dissolve at the ordinary temperature. From this into paraffin softened with chloroform, the melting-point of which is about 36° C. The specimens are kept in this melted paraffin 24 hours. I have always been careful not to let the temperature go above 47° C., although I think it probable that a somewhat higher temperature would not injure the tissue of a seed. From this the seed may be imbedded in hard paraffin, and will be found to be thoroughly infiltrated.

The seeds may be sectioned in the paraffin blocks either free-hand or with a microtome. It is highly essential that the sections be kept in series, and that none be missing. The texture of a seed is so fragile that when cut in thin sections the least carelessness may spoil a section. A very effectual way to keep sections intact when they are cut in paraffin is that proposed by Dr. Mark.* It consists in collodionizing the object as the sections are taken. Very thin collodion should be used, and applied to the cut surface after the section is taken, Lee† recommends that 'the collodion be of such a consistency that,

* Amer. Nat., 1885, p. 628. † 'Vade-mecum,' 2nd ed., p. 150.

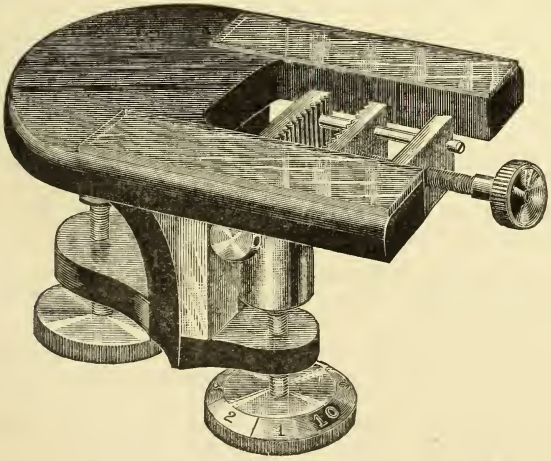
when applied to a surface of paraffin, it dries in two or three seconds. This has no tendency to cause the sections to roll. . . . As soon as the collodion is dry, which ought to be in two or three seconds, cut the section, withdraw the knife, and pass the collodionized brush over the newly exposed surface of paraffin.' The sections are placed collodion side down on the slide. They may be fastened by first painting the slide with a few drops of clove-oil collodion, placing them in it, and then evaporating off the clove oil.

The sections are then placed in xylol for 15 minutes. This removes the paraffin. They are then washed in alcohol, afterwards with water, and stained. I have found no stain that was as effective in staining seeds as hæmatoxylin. They should be stained from 3 to 5 minutes. After washing the staining agent away with water, dehydrate with alcohol, and clear. Three parts of turpentine and two parts of carbolic acid make a very good clearing mixture. Canada balsam dissolved in xylol is used for mounting. In sections thus prepared one can distinguish without difficulty in shepherd's purse, golden-rod, or any endospermous seed, the coats, the plumule composed, as is the lower tip of the radicle, of small thin-walled nucleus-bearing cells. These two regions of growth are connected by slightly elongated cells, which are also thin-walled. The larger cells making up the tissue of the cotyledons are stored with food. In many seeds a trace of a fibrovascular system may be seen; also the peculiar arrangement and markings of the cells composing the coats.

Seeds differ so much, that one would need to make many variations in method to suit different cases; but as a general method I have found this to be a success, and I believe the histology of any seed may be demonstrated by applying it."

Microtome.*—Messrs. Bausch and Lomb write:—"We have found that the section-cutters formerly made by us and other manufacturers

Fig. 14.



* Proc. Amer. Soc. Micr., xi. (1889) pp. 133-4.

are in some respects not suited to modern requirements. We have therefore ceased to make such, and have replaced them by new instruments, which we shall hereafter class under the head of microtomes.

The instrument presented here is dissimilar from the Laboratory and Student microtomes of our manufacture in not having mechanical movement for the knife; it is intended to be fastened to the table-top by means of thumb-screw. The cutting-plate of the instrument is inlaid with glass to obtain perfect smoothness. To the carriage are directly fitted the micrometer-screw with graduated disc, and a section-clamp which is acted upon by the former. The pitch of the screw is 1/50 in., graduation on disc 10, and the finest degree of feed 1/500 in. The regular section-knives as well as the ordinary razors can be used with the instrument."

(4) Staining and Injecting.

Brown-staining Bacillus.* — Herr D. Scheibenzuber describes a bacillus which he has isolated from rotten plover's eggs, and of which the chief characteristic is that it stains the gelatin in the immediate vicinity of the colonies of a brownish colour. The colonies when grown on plates are stated to consist of a central area, which is surrounded by a radiately striated zone. The gelatin surrounding the colonies is not liquefied; when cultivated in test-tubes (puncture cultivation), the inoculation track becomes characteristically serrated, and produces a brown pigment.

When examined with 1/20 oil-immersion the micro-organism is found to be a short bacillus pointed at both ends.

New Method for Staining and Mounting Tubercle Bacilli.†— Dr. H. Kühne recommends the following method for staining tubercle bacilli:—

After the cover-glasses have been prepared, that is, coated with sputum and dried in the flame, they are stained in carbolic fuchsin for five minutes. They are then thoroughly decolorized in 30 per cent. nitric or sulphuric acid, and subsequently washed in water and dried. After this they are examined in a drop of anilin oil stained slightly yellow with picric acid. This mixture is best made by adding 2 to 3 drops of concentrated solution of picric acid in anilin oil to a capsule full of anilin oil.

Preparations obtained in this way will remain fit for examination for at least a week. If permanent preparations are desired, the cover-glass, after it has been decolorized by the mineral acid, is placed for some minutes in an aqueous solution of picric acid, then dried and mounted in the usual manner.

Staining Flagella of Spirilla and Bacilli.‡—Dr. Trenkmann finds that the flagella of bacteria may be stained with very satisfactory results in the following manner:—

The cover-glass having been prepared from a cultivation in the usual manner, is immersed for 6 to 12 hours in a solution of 2 per cent.

* Mittheil. aus d. Embryol. Institute d. K. K. Univ. Wien, 1890, pp. 1–9 (4 figs.).
† Centralbl. f. Bakteriol. u. Parasitenk., viii. (1890) pp. 293–7.
‡ T. c., pp. 385–9.

tannin and 1/2 to 1/4 per cent. HCl. The preparations are next carefully washed and placed in iodine water. Gram's iodine or one drop of iodine tincture to 10 ccm. water does very well, but iodine mixed with water and allowed to stand for 24 hours (shaking frequently) answers better.

In the iodine solution the covers remain for about one hour; they are then washed in water, and stained with gentian-violet. The violet solution is made in a 25 ccm. test-tube. One drop of a saturated alcoholic solution of gentian-violet solution is mixed with 10 ccm. distilled water. Half of this is poured away and the test-tube filled up with anilin water. In this solution the covers remain for about 30 minutes.

Afterwards the author advises using a less quantity of hydrochloric acid, and to have three different solutions, viz.:—Two per cent. tannin, with 1, 2, and 3 per 1000 HCl. The 1 per 1000 may be made by mixing 10 grm. of a 2 per cent. tannin solution and 2 drops of 8 per cent. HCl.

Impregnation of Bone Sections with Anilin Dyes.*—Herr N. Matschinsky finds that saturated aqueous solutions of anilin pigments are excellent for demonstrating the growth-appearances of bone. The pigments used were eosin, safranin, gentian-violet, methylen-blue, methyl-green, iodide-green, and fuchsin, and though all were satisfactory, eosin and safranin gave the best results.

The bones examined were sectioned transversely and longitudinally, and were both macerated and fresh. If fresh, the fat was removed by immersing the sections for half an hour in ether, and after having been polished up, the dust removed, and washed in water, they were transferred to the staining solution.

Macerated bones were allowed to remain for about 48 hours, but if kept at a temperature of 40° C., the staining was more rapid. Sections of fresh bone stained more slowly.

When removed from the staining solution the sections were dried, and having been again carefully polished up, were examined in air or in Canada balsam.

From examination of different bones and bones of different ages (young, adult, old), it was found that the staining was proportionate to the changes going on. Thus, in young bone the staining was more pronounced in the subperiosteal and subendosteal regions than in adult bones, and much more than in old osseous tissue.

(5) Mounting, including Slides, Preservative Fluids, &c.

To rectify Turpentine for Microscopical Use.†—Mr. Charles C. Faris writes:—As it is difficult to obtain nice, clear turpentine for microscopical purposes, I want to give other workers the benefit of my experience in rectifying the ordinary fluid. I proceed as follows:—

Take one pint of the common turpentine and mix in a quart bottle with 4 oz. of 98 per cent. alcohol. Agitate well, and let stand until the two fluids separate. Decant the turpentine (which will form the lower layer) from the alcohol, and mix it with one pint of clear water.

* Anat. Anzeig., x. (1890) pp. 325–36. † The Microscope, x. (1890) p. 179.

Agitate thoroughly, and let stand until these two fluids separate, then from the water decant the turpentine (which this time will form the upper layer), and finally, mix with the turpentine about 1 oz. of powdered starch, and filter through paper.

By pursuing the foregoing plan any one may secure a pure, limpid, and brilliant turpentine. The alcohol used in rectifying it need not be wasted, as it will do to burn, to clean slides, or for other purposes. I usually make a large quantity, and recover the alcohol by distillation.

(6) Miscellaneous.

Biological Examination of Potable Water.*—Mr. G. W. Rafter describes a modification of Prof. W. T. Sedgwick's method of determining the number of organisms in drinking water. The water is filtered through a short column of fine sand in the stem of a funnel, the sand being supported on a plug of wire-cloth placed beneath it. The sand retains the whole of the organisms contained in the water. After the completion of the filtration, the sand is washed with distilled water into a test-tube, and shaken, when all the sand falls to the bottom and the organisms remain uniformly distributed through the water. A definite quantity of this is taken out by a pipette and placed in a cell of known dimensions. The enumeration of the organisms is accomplished by transferring the cell to the stage of the Microscope and examining with the aid of the micrometer.

Tests for Glucosides and Alkaloids.† — Herr A. Rosoll gives the following tests for berberin and cytisin:—Berberin dissolves in concentrated nitric acid with a reddish-brown colour, and may then be precipitated in star-like groups of crystals of berberin nitrate by the successive action of alcohol and nitric acid; or it can be precipitated as characteristic green capilliform crystals by potassium iod-iodide from the alcoholic solution; the crystals being again soluble in sodium hyposulphate. It occurs in all the organs of mature plants of *Berberis vulgaris*. Cytisin occurs in all parts of the laburnum, but there are only traces in the leaves or flowers. It gives a red-brown precipitate with potassium iod-iodide, leaf-like groups of crystals with picric acid; a light reddish-yellow solution with sulphuric acid, which becomes yellow, brown, and finally green, on addition of a small piece of potassium bichromate; a yellow turbidity with phosphor-molybdic acid. Tests are also given for coniferin, phloroglucin, vanillin, salicin, syringin, hesperidin, solanin, saponin, tannin, veratrine, strychnine, brucine, colchicine, nicotine, aconitine, and atropine. The author asserts that strychnine occurs in solution in the drops of oil held in solution in the endosperm-cells, and not, as sometimes stated, in the thickenings of the cell-walls.

Materials of the Microbe-Raiser.‡—Dr. S. Hart makes the following somewhat amusing remarks:—"Some of the means and methods

* Proc. Rochester (N.Y.) Acad. Sci., 1890, 10 pp. and 4 figs.

† 'Ueb. d. mikrochemischen Nachweis d. Glycoside u. Alkaloide,' Stockerau, 1890, 25 pp. See Bot. Centralbl., xliv. (1890) p. 44.

‡ "Invisible Assailants of Health," 'Popular Science Monthly.' See Amer. Mon. Micr. Journ., xi. (1890) p. 232.

of the micrologist in his researches must be mentioned. His outfit is extensive and novel. It includes the best known Microscopes and a well-constructed incubator with heater and thermometer, numerous test-glasses, beakers, filters, acids, alkalies, deep-coloured dyes, and a good supply of prepared cotton.

In studying the life-history of his microbes he will require a well-supplied commissariat. He must be a professional caterer and a bountiful feeder. He must have fluids, semi-fluids, and solids, broths of various meats, peptonized food, the serum of blood *à la Koch*, and Pasteur's favourite recipe with the French refinement: Recipe, 100 parts distilled water, 10 parts pure cane-sugar, 1 part tartrate of ammonium, and the *ash* of 1 part of yeast. Among the substantials must be found boiled white of egg, starch, gelatin, Japan isinglass, and potato, the last from South as well as North America."

A Query.—As "Novice" will perhaps get the best advice by means of our Journal we hasten to give his questions the widest publicity we can:—"I am thinking of starting a street exhibition with four Microscopes (two by Beck and two by Watson). Will some kind reader please tell me which objectives I should use to please the public most —1/4, 1/2, 1, 2, or 3 in.? Also please tell me of a few good mounted objects that will please them as well; and which objectives I should use to get the best result when examining a frog's foot. And do you think there is a living of, say, 35*s.* per week by going from town to town? Any information on the above will be gladly received by—Novice."

* Eng. Mech., lii. (1891) p. 471.

PROCEEDINGS OF THE SOCIETY.

Meeting of 17th December, 1890, at 20, Hanover Square, W., Prof. Urban Pritchard, Vice-President, in the Chair.

The Chairman having declared the meeting to be made special for consideration of matters adjourned from the adjourned special meeting held 19th November, the Secretary said that the Council were still unable to recommend any course of action on the matters under consideration, and therefore advised that the adjournment of the special meeting be *sine die*.

It was moved by Mr. J. M. Allen, seconded by the Rev. Canon Carr, and resolved, "That this special meeting be adjourned *sine die*."

The Minutes of the meeting of 19th November last were then read and confirmed, and were signed by the Chairman.

The List of Donations (exclusive of exchanges and reprints) received since the last meeting was submitted, and the thanks of the Society given to the donors.

	From
Six Slides of *Leptodora hyalina*	.. .. *Mr. T. Clarke.*
Slide of *Ceratium longicorne*	
Three Lithographs of Fresh-water Sponge	.. .. *Mr. J. Clark.*
Two Photomicrographs of ditto	

Mr. T. Clarke's letter relating to his donation of slides was read.

Mr. Joseph Clark's description of his lithographs and photomicrographs was read.

Mr. G. F. Dowdeswell's note was read with reference to a small eye-piece thread-micrometer which he had sent to the meeting for exhibition, and which he stated was made about five years ago, and embodied the same principles as the one exhibited by Mr. Nelson at the meeting of the Society in May, and described in the August number of the Journal. A short further communication from Mr. Dowdeswell was also read in reply to some observations and inquiries with reference to the "simple form of warm stage," exhibited and described at the meeting of the Society in October last.

Mr. J. Mayall, jun., said he thought that the means by which it was proposed to keep this stage warm—i. e. by applying a small flame below the projecting corner of it—were not sufficiently precise to render it possible to keep the temperature within a variation of one degree, as suggested by Mr. Dowdeswell. According to the opinion of Dr. Dallinger it was of the utmost importance, that in all observations bearing upon the influence of temperature on the forms of life and development, the means of regulating and maintaining the temperature of the stage should be absolutely under control, and he feared this could hardly obtain with the method described by Mr. Dowdeswell.

Mr. E. M. Nelson having examined the micrometric eye-piece, said it appeared to him to be a "Jackson eye-piece micrometer," and that was

all. It had no movable thread so far as he could see; the scale moved sometimes, but not the web.

Mr. Mayall said the apparatus was so shaky that he supposed it had met with an accident. The general construction reminded him of the designs of the Continental screw-micrometers, and also of the screw mechanism frequently employed on the Continent for stage movements, centering, &c., in most of which unnecessarily long and thin screws were applied, which were very liable to be bent, and to become loose in their sockets. He thought the defective condition of Mr. Dowdeswell's micrometer should serve as a warning to opticians generally of the error of making screw-axes too long and thin, especially those having milled heads, and, consequently, intended to be moved by hand. In all the high-class screw-micrometers and similar mechanism, the actuating screws and their bearings were made large and substantial, with a view to securing accuracy of movement, durability, and freedom from flexure. He might mention particularly that in examining a large number of Microscopes by different makers, he had observed that the centering screws of the mechanical substages were generally too slight, and were provided with such short sockets that they were very liable to become shaky. These were points of importance in the construction of Microscopes and accessory apparatus.

Mr. Mayall said he had prepared a short note for publication in the Journal (see *ante*, p. 107) upon a matter in connection with photo-micrography, which he thought the Fellows of the Society would agree with him called for some protest—the practice of sending photographs there as specimens and illustrations without at the same time stating the details of the process by which they were produced. On submitting the note to Prof. Bell, it had been thought advisable to deal with it as a communication to the Society, in the hope that it might lead to useful discussion. Before inviting discussion, he said his attention had been specially drawn to the subject by the fact that at one of their recent meetings a photograph of *P. angulatum*, by Dr. Van Heurck, had been exhibited, and had elicited from Mr. Frank Crisp the observation that it was "remarkable." In making that observation, Mr. Crisp certainly supposed that he was criticizing a photo-micrograph pure and simple—produced directly with the Microscope—and on the fact of that supposition the observation was doubtless fully justified. On examining the print again more closely, he (Mr. Mayall) was inclined to suspect that it was not really a photomicrograph, but merely an enlarged copy of one, and that a very large part of the strength of the image was probably due to the copying process employed. He therefore applied to Dr. Van Heurck for information and found that the print was an enlarged copy, as he had suspected. He thought that was an important example to cite of the erroneous value that might be given to a photographic rendering of a microscopic object, in consequence of the full and proper data not having accompanied the photograph; for assuredly, if Mr. Crisp had been aware of these data, his commendation of the photograph would have been modified. Mr. Mayall explained that the limit of useful magnification for the

production of photomicrographs had hitherto been found at about 1000 diameters, and it should not be overlooked that differences in the photographic manipulations would very largely influence the results obtained by different workers. He thought that many workers had been rather betrayed by the reducing power of some of the more recent developing agents, such as hydroquinone, and, instead of aiming at the reproduction, as far as possible, of the images seen in the Microscope, they had aimed at producing photomicrographs of the greatest possible strength of contrast, and thus exaggerated effects of black and white had become the order of the day. Those who had not the facility of producing photomicrographs were thus apt to think their own manipulation with the Microscope must be defective, because they found it impossible to see in the Microscope images so strong and definite as those shown in the recent photomicrographs.

Mr. E. M. Nelson said the subject was one of importance in connection with matters which had occupied much of his attention. As regarded the 1000 diameter limit mentioned by Mr. Mayall, he thought he had been able to exceed that, his experience leading him to say that sharpness could be obtained up to 20 times the initial magnifying power of the lens. He had produced good photographs direct from the Microscope up to × 1500, and recently showed one untouched and undoctored × 1650. In most cases, however, × 1000 would be found a useful limit; and he might add that he had taken sharp pictures with a 1 in. objective exceeding 20 times the initial power of the lens. With regard to the hydroquinone developer, he thought it would not give more contrast than was obtained in other ways; if they had a feeble image on the screen they would only get a feeble photograph from it, and with high powers he had never been able to get in this way much more than he could see. But with lower powers they could undoubtedly get very strong contrasts, and could sharpen up a picture with hydroquinone, using lenses up to 1/4 in. dry, though it could not be done with an oil-immersion. With a dry 1/4 in., or with a 1 in. lens, they could under-expose and then get a perfectly black and white "chalky" picture, as mentioned by Mr. Mayall. As regarded enlargement, it was a thing he was utterly opposed to, and he thought that all such prints ought to be marked as such, on front and back too, if necessary, to prevent any one being deceived by them. Intensification should be regarded much in the same way; the picture shown ought to be the same as the image seen. He did not believe in effects produced by doctoring processes, either carried out by chemicals or by projection with a lens. These were purely mechanical processes, and as useless for scientific purposes as if drawn with a brush upon the screen.

The Chairman inquired if they could tell whether the photograph before them was an enlargement, or whether it had been taken direct?

Mr. Nelson said it was easy to say it was an enlargement, but the method employed in its production could not be determined by inspection. The chief use of enlargement was to convert a poor, weak picture into a bold, sharp one.

The Chairman remarked that people who were dissatisfied with a photograph were accustomed to be told that the sun could not lie; but

it seemed as if something of the sort could happen through the medium of the processes mentioned.

Mr. Mayall said that when a draughtsman made a drawing of an image seen in the Microscope, he adopted some conventional method of representing differences of colour, light and shade, &c., and in some points his personal equation was an important factor, as evidenced by the different renderings that would be given by different draughtsmen. Bnt it should not be supposed that by means of photography all these difficulties were conquered, and that the photographic interpretation could be wholly relied upon for giving uniform results. Photography itself might be said to have a considerable range of "photographic equation," due to the variety in the processes that were available, and it was an extremely difficult matter to suggest any one process that should be regarded as a standard or guide for general adoption in connection with Microscopy. It was quite certain that a skilled manipulator could so direct the processes that almost any point could be accentuated in a photograph. As an example, he might mention that Mr. Nelson had shown him negatives of a *Triceratium* in which the general contours of a hexagonal "pit" were very well shown, but in which it was hardly possible to detect any differentiation at the bottom of the pit, though in the Microscope a dotted appearance was seen. A new negative was made with much less exposure, and though the general contours were not so evident, the dotted appearance in the pits was shown. This was clearly an instance that photography had its own methods or conventionalities in dealing with particular points—the mere reduction of the exposure enabled the sensitive film to pick up faint differences in luminousness of closely adjacent parts which had previously been blurred together by the over-exposure. He thought the importance of having the full data given with every photomicrograph would soon be recognized, and that the comparison of results would thus become more useful. At present the matter was somewhat chaotic, for it frequently happened that the processes employed were so mixed up that no proper comparisons could be made. Photomicrographs were produced with sunlight, diffused daylight, electric light, oxy-hydrogen light, petroleum light, gaslight, &c.; the negatives were intensified or not, or were developed in some special way; the exposures were timed to exhibit this or that point; the plates were isochromatic or not; and yet the results were dealt with as if the comparisons were being fairly made on the same lines. Or, again, enlarged photographs were made from many of these photomicrographs by processes which were known to completely alter the character of the originals, and these were compared with each other, or with the various originals, in such a way that the whole subject became confused. In twenty years hence, the student who should examine the Society's collection of photographs would be sorely puzzled to determine what the present generation of photomicrographers had really been aiming at.

The Chairman thought the thanks of the Society were due to those gentlemen who had favoured them with communications, and who had sent exhibits to the meeting. The causes which had operated in preventing the attendance of the President and Prof. Bell had no doubt deterred many others from being present that evening. He also announced that

the next meeting would be the Annual Meeting in conformity with the alteration in the Bye-laws, and would be held on January 21st, when the election of Officers and Council would take place, and the President would deliver his annual address.

The Chairman said that in conformity with the Bye-laws the Council had nominated Mr. W. T. Suffolk to audit the Treasurer's account, and a second Auditor must be appointed by the Fellows. On the motion of Mr. J. Mason Allen, seconded by the Rev. Canon Carr, Mr. J. D. Hardy was appointed as Auditor.

The following Instruments, Objects, &c., were exhibited :—

Mr. J. Clark :—Lithographs and Photomicrographs of early stage of Freshwater Sponge.

Mr. T. Clarke :—Slides of *Leptodora hyalina* and *Ceratium longicorne*.

Mr. G. F. Dowdeswell :—Eye-piece Thread-micrometer.

New Fellows :—The following were elected *Ordinary* Fellows :—Messrs. Lawrence Briant, F.C.S., and William Snow, B.A.

ANNUAL MEETING, HELD 21ST JAN., 1891, AT 20, HANOVER SQUARE, W., THE PRESIDENT (DR. C. T. HUDSON, F.R.S.) IN THE CHAIR.

The Minutes of the meetings of 17th December last were read and confirmed, and were signed by the President.

The List of Donations (exclusive of exchanges and reprints) received since the last meeting was submitted, and the thanks of the Society given to the donors.

	From
Cowan, T. W., The Honey Bee: its Natural History, Anatomy, and Physiology. xi. and 220 pp., 72 figs., and frontispiece. (8vo, London, 1891)	*The Author.*

The President said it was with great regret that he had to notify the death of one of their Honorary Fellows, Dr. H. B. Brady, F.R.S. He had suffered, as no doubt they were aware, from a long illness, and had died at a comparatively early age, but he had left behind him, as the fruit of twenty-five years' study of the Foraminifera, results that might well be considered the ample reward of long life and unvarying health. For, besides many memoirs on his favourite subject, written either alone or in conjunction with the late Prof. W. Kitchen Parker and Prof. Rupert Jones, he published single-handed that splendid report on the Foraminifera of the 'Challenger' expedition, which had so extended their knowledge, and confirmed his high reputation. On his enthusiasm and unflagging industry it was needless for him to dwell; but he might be permitted to add, that those who had the pleasure of knowing him well, mourned for the loss, not only of an accomplished scientist, but of a sterling friend. In addition to this loss, he had also to record the death of Prof. G. Govi, another of their Honorary Fellows, which occurred in 1889, but the notification of which was omitted from the Report of the Council in 1890. To fill the vacancies thus created, it was proposed to elect Prof. Hermann Fol, of Nice, and Prof. Sir Joseph Lister, Bart., F.R.S., nominations in favour of whom were then read to the meeting and ordered to be suspended in the usual manner.

Mr. Swift exhibited and described a new form of Petrological Microscope which he had made under the instructions of Mr. Allen Dick, which differed from the ordinary patterns in having no revolving stage, but was so constructed that, whilst the object remained fixed, the eye-piece and the tube below the stage could be revolved.

The President expressed the thanks of the Society to Mr. Swift for exhibiting and explaining the features of this Microscope.

Mr. E. M. Nelson exhibited a new Apochromatic Condenser by Powell and Lealand, which gave a larger aplanatic solid cone than it had hitherto been found possible to obtain.

Prof. Bell then read the Report of the Council for the past year, as follows :—

REPORT OF THE COUNCIL.

Fellows.—During the year 1890, forty-one new Fellows were elected, which is about the average of the last ten years, whilst thirty-six died or resigned.

Three Honorary Fellows, Prof. H. Frey, Prof. W. Kitchen Parker, F.R.S., and Mr. J. Ralfs, died; their places were supplied by the election of Prof. Leydig, of Würzburg, the most distinguished of living histologists, Mr. H. B. Brady, F.R.S., well known for his numerous writings on Foraminifera, and Prof. W. C. Williamson. F.R.S., whose investigations have told us so much as to the flora of past ages.

The death of Prof. G. Govi, Honorary Fellow, occurred in 1889, but his name was inadvertently omitted from the Report of last year.

The list of Fellows now contains 663 Ordinary Fellows, 1 Corresponding, 49 Honorary, and 88 Ex-officio, or a total of 801.

Finances.—As many of the Fellows who died or resigned were either compounders or subscribers under the old scale of one guinea, the annual revenue from subscriptions has been increased by 29*l.* 8*s.*

The capital funds of the Society are 1200*l.* in freehold mortgages, and 780*l.* 17*s.* 3*d.* invested in India 3 per cents., which is 95*l.* 2*s.* 5*d.* less than the amount reported last year, this being the sum expended in the removal of the Society's property from King's College to the premises now occupied.

Rooms.—The Council are glad to report that the removal of the Library, Instruments, &c., to the new premises, at 20, Hanover-square, was effected without accident or loss of any kind.

Library.—The Council note that during the past year the increased usefulness of the Library has been evidenced by the number of Fellows visiting the rooms or applying for the circulation of volumes, periodicals, &c., by means of the printed catalogue now issued.

The Council are aware that the Society's collection of works on the Microscope requires large additions to render it available for historical reference, and they hope progress will be made in the near future towards greater completeness of the Library in this direction.

Instruments.—The Council are informed by the Secretaries that several applications have been made by Fellows during the past year for the use of a high-class Microscope, with objectives, &c., of the most approved construction, and they hope to deal with the subject satisfactorily during the ensuing year, as they fully recognize the importance of having such an instrument at the disposal of the Fellows.

Journal.—The Council observe that, under the editorship of Prof. F. Jeffrey Bell, the Journal has been maintained on the lines so ably laid down by Mr. Frank Crisp, and they trust that the continued publication on those lines will lead to its augmented prosperity.

Transactions.—The Council urge upon the Society the great importance of obtaining original communications for publication in the 'Transactions'; they would impress upon the Fellows that such communications are of special interest at the meetings, and that it is on their publication that the scientific position of the Society is estimated.

Upon the motion of Mr. J. M. Allen, seconded by the Rev. Canon Carr, it was resolved that the Report be received and adopted.

The Treasurer, Mr. Frank Crisp, presented his annual statement of accounts, and read the balance-sheet, duly audited by Messrs. Suffolk and Hardy, who were elected Auditors at the preceding meeting (see p. 158).

Upon the motion of Prof. Lionel S. Beale, F.R.S., seconded by Dr. Hebb, the adoption of this Report, together with a vote of thanks to the Treasurer for his services during the past year, was duly passed.

The President having appointed Mr. J. Mason Allen and Mr. Edward M. Nelson to act as Scrutineers, the ballot for the election of Officers and Council for the ensuing year was proceeded with.

The President then read his Annual Address (see p. 6), concluding with the exhibition of a number of coloured transparencies, some in illustration of portions of his subject, and others to demonstrate the adaptation of this plan for the display of diagrams on various points in natural history and astronomy.

The Rev. Canon Carr said he rose for the purpose of heartily thanking the President for the address which he had just delivered, and for the exhibition of his beautiful drawings. The Fellows were thankful to see him amongst them again, and hoped that his presence might be regarded as an indication that his health had been fully restored. They also further hoped that the fears which had been entertained with regard to his eyesight might not be realized. He felt sure that all who were present had been very much pleased with the address, and would heartily join in giving their best thanks to the President for it.

Prof. Bell had much pleasure in seconding the vote of thanks to the President for his address, and also for his services to the Society during the past year. The lateness of the hour, and the knowledge that Dr. Hudson was anxious to leave as soon as possible, were reasons why he should not make any lengthened remarks in support of a resolution which he felt sure commended itself to every Fellow of the Society who had listened to the address: he would therefore ask Canon Carr to put it at once to the meeting.

The motion was then put to the meeting, and carried by acclamation.

The President, in reply, thanked the Fellows of the Society heartily for the cordial manner in which they had received his address, and also for the honour done to him by his election as President during the three previous years. In accepting the office, he had fully anticipated that the state of his health would have admitted of his attendance at the meetings more often than had unfortunately been possible; but he could assure them that it had given him great pleasure to come as often as he had been able, and he hoped still to be able to come to future meetings whenever circumstances permitted.

THE TREASURER'S ACCOUNT FOR 1890.

Dr. 1890.	£	s.	d.	Cr. 1890.	£	s.	d.
To Balance brought from 31st December, 1889	114	19	6	By Rent, Gas, and Attendance	192	17	6
„ Interest on Investments	77	14	3	„ Salaries, Reporting, and Commission	194	9	0
„ Admission Fees	79	16	0	„ Books and Binding	114	2	0
„ Annual Subscriptions	884	3	2	„ Expenses of Journal (less receipts)	539	19	2
„ Compositions	139	2	6	„ Postage of Journal	56	4	5
„ Reprints of papers sold	6	1	6	„ Reprints of Papers	5	16	0
„ Catalogues sold	0	15	0	„ Stationery and Miscellaneous Printing	35	15	3
„ Old Chairs and Cases sold	8	16	0	„ Coffee at Evening Meetings	19	2	6
„ India 3 per cent. Consols sold (£95 2*s.* 5*d.*)	90	0	0	„ Fire Insurance	2	5	0
				„ Petty Cash	39	11	0
				„ Expenses of Removal	90	15	11
				„ Balance remaining 31st December, 1890	110	10	2
	£1401	7	11		£1401	7	11

Frank Crisp, *Treasurer.*

Investments, 31*st December*, 1890.

1200*l.* Freehold Mortgages. 780*l.* 17*s.* 3*d.* India Three per Cents. (including 100*l.* Quekett Memorial Fund).

The foregoing Annual Account examined and found correct, 5th January, 1891.

J. D. Hardy,
W. T. Suffolk, } *Auditors.*

The Scrutineers having handed in the result of their examination of the balloting papers,

The President declared that all the Fellows nominated were elected as follows:—

President—*Robert Braithwaite, Esq., M.D., M.R.C.S., F.L.S.

Vice-Presidents—*Prof. J. William Groves, F.L.S.; *Albert D. Michael, Esq., F.L.S.; *Prof. Charles Stewart, Pres. L.S.; Charles Tyler, Esq., F.L.S.

Treasurer—Frank Crisp, Esq., LL.B., B.A., V.P. and Treas. L.S.

Secretaries—Prof. F. Jeffrey Bell, M.A.; and John Mayall, Esq., Jun., F.Z.S.

Twelve other Members of Council—*Prof. Lionel S. Beale, M.B., F.R.C.P., F.R.S.; Alfred W. Bennett, Esq., M.A., B.Sc., F.L.S.; Rev. W. H. Dallinger, LL.D., F.R.S.; *James Glaisher, Esq., F.R.S., F.R.A.S.; Richard G. Hebb, Esq., M.A., M.D.; *Charles T. Hudson, Esq., M.A., LL.D. (Cantab.), F.R.S.; George C. Karop, Esq., M.R.C.S.; Thomas H. Powell, Esq.; *Prof. Urban Pritchard, M.D.; Walter W. Reeves, Esq.; William Thomas Suffolk, Esq.; and Frederic H. Ward, Esq., M.R.C.S.

Mr. G. C. Karop then moved that the thanks of the Society be given to the Auditors and Scrutineers for their services, and the motion having been seconded by Mr. F. Justen, was put to the meeting by the President, and carried unanimously.

The President said he had now the pleasure of welcoming to the Chair his well-known and learned successor Dr. Braithwaite, and of congratulating the Society, not only on so happy a choice, but also on the fact that the Zoological Dynasty had made way for a Botanical one. Variety was the salt of life, and it was a fortunate thing that their large and flourishing Society contained members who, though of very various tastes, resembled one another in their zealous pursuit of natural science, and in the success with which they pursued it. With the wish that Dr. Braithwaite might have a long, happy, and prosperous reign, he became now one of the most loyal of his subjects.

Dr. Braithwaite, who was very cordially received on taking the Chair, said he had in the first instance to thank the retiring President for the kind way in which he had referred to him, and next to thank the Fellows of the Society for the honour conferred upon him by his election to the position he was about to occupy. He could assure them that, so far as he was able to sustain it, the high position which the Society then held should not suffer from the change which they had made. He knew that the position was not a light one, but he was encouraged by the sight of many old friends before him to believe that those who so ably assisted him in the discharge of similar duties at another Society some years ago, would also give him the benefit of their assistance during the coming year. One observation, however, he should very much like to make before he sat down; he thought it very desirable that original papers should fill a much

* Have not held during the preceding year the Office for which they were nominated.

larger space in the Journal than was at present the case. The Journal had already a world-wide reputation, and the surest way to maintain this would be to increase as far as possible the number and value of their original communications to the Society.

The following Instruments, Objects, &c., were exhibited.

Mr. E. M. Nelson:—Powell and Lealand's new Apochromatic Condenser.

Mr. J. Swift:—Improved form of Dick's Polarizing Microscope.

New Fellows:—The following were elected Ordinary Fellows:—Messrs. Alfred L. Blow, F.C.S., and Arthur D. Howard.

The Journal is issued on the third Wednesday of
February, April, June, August, October, and December.

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JOURNAL

OF THE

ROYAL MICROSCOPICAL SOCIETY;

CONTAINING ITS TRANSACTIONS AND PROCEEDINGS,

AND A SUMMARY OF CURRENT RESEARCHES RELATING TO

ZOOLOGY AND BOTANY

(principally Invertebrata and Cryptogamia),

MICROSCOPY, &c.

Edited by

F. JEFFREY BELL, M.A.,

One of the Secretaries of the Society
and Professor of Comparative Anatomy and Zoology in King's College;

WITH THE ASSISTANCE OF THE PUBLICATION COMMITTEE AND

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JOHN MAYALL, JUN., F.Z.S.,
R. G. HEBB, M.A., M.D. (*Cantab.*),

AND

J. ARTHUR THOMSON, M.A.,
Lecturer on Zoology in the School of Medicine, Edinburgh,
FELLOWS OF THE SOCIETY.

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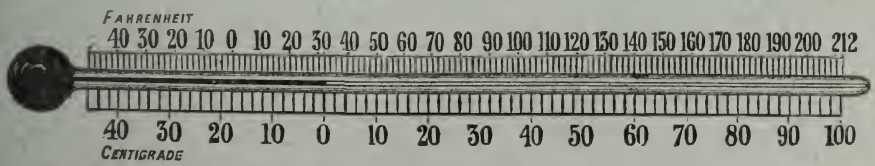
APERTURE TABLE.

Numerical Aperture. ($n \sin u = a$.)	Corresponding Angle ($2u$) for			Limit of Resolving Power, in Lines to an Inch.			Illuminating Power. (a^2.)	Penetrating Power. $\left(\frac{1}{a}\right)$
	Air ($n = 1{\cdot}00$).	*Water* ($n = 1{\cdot}33$).	*Homogeneous Immersion* ($n = 1{\cdot}52$).	White Light. ($\lambda = 0{\cdot}5269\ \mu$, Line E.)	Monochromatic (Blue) Light. ($\lambda = 0{\cdot}4861\ \mu$, Line F.)	Photography. ($\lambda = 0{\cdot}4000\ \mu$, near Line h.)		
1·52	..	..	180° 0′	146,543	158,845	193,037	2·310	·658
1·51	..	..	166° 51′	145,579	157,800	191,767	2·280	·662
1·50	..	..	161° 23′	144,615	156,755	190,497	2·250	·667
1·49	..	..	157° 12′	143,651	155,710	189,227	2·220	·671
1·48	..	..	153° 39′	142,687	154,665	187,957	2·190	·676
1·47	..	..	150° 32′	141,723	153,620	186,687	2·161	·680
1·46	..	..	147° 42′	140,759	152,575	185,417	2·132	·685
1·45	..	..	145° 6′	139,795	151,530	184,147	2·103	·690
1·44	..	..	142° 39′	138,830	150,485	182,877	2·074	·694
1·43	..	..	140° 22′	137,866	149,440	181,607	2·045	·694
1·42	..	..	138° 12′	136,902	148,395	180,337	2·016	·709
1·41	..	..	136° 8′	135,938	147,350	179,067	1·988	·709
1·40	..	..	134° 10′	134,974	146,305	177,797	1·960	·714
1·39	..	..	132° 16′	134,010	145,260	176,527	1·932	·719
1·38	..	..	130° 26′	133,046	144,215	175,257	1·904	·725
1·37	..	..	128° 40′	132,082	143,170	173,987	1·877	·729
1·36	..	..	126° 58′	131,118	142,125	172,717	1·850	·735
1·35	..	..	125° 18′	130,154	141,080	171,447	1·823	·741
1·34	..	..	123° 40′	129,189	140,035	170,177	1·796	·746
1·33	..	180° 0′	122° 6′	128,225	138,989	168,907	1·769	·752
1·32	..	165° 56′	120° 33′	127,261	137,944	167,637	1·742	·758
1·30	..	155° 38′	117° 35′	125,333	135,854	165,097	1·690	·769
1·28	..	148° 42′	114° 44′	123,405	133,764	162,557	1·638	·781
1·26	..	142° 39′	111° 59′	121,477	131,674	160,017	1·588	·794
1·24	..	137° 36′	109° 20′	119,548	129,584	157,477	1·538	·806
1·22	..	133° 4′	106° 45′	117,620	127,494	154,937	1·488	·820
1·20	..	128° 55′	104° 15′	115,692	125,404	152,397	1·440	·833
1·18	..	125° 3′	101° 50′	113,764	123,314	149,857	1·392	·847
1·16	..	121° 26′	99° 29′	111,835	121,224	147,317	1·346	·862
1·14	..	118° 0′	97° 11′	109,907	119,134	144,777	1·300	·877
1·12	..	114° 44′	94° 55′	107,979	117,044	142,237	1·254	·893
1·10	..	111° 36′	92° 43′	106,051	114,954	139,698	1·210	·909
1·08	..	108° 36′	90° 34′	104,123	112,864	137,158	1·166	·926
1·06	..	105° 42′	88° 27′	102,195	110,774	134,618	1·124	·943
1·04	..	102° 53′	86° 21′	100,266	108,684	132,078	1·082	·962
1·02	..	100° 10′	84° 18′	98,338	106,593	129,538	1·040	·980
1·00	180° 0′	97° 31′	82° 17′	96,410	104,503	126,998	1·000	1·000
0·98	157° 2′	94° 56′	80° 17′	94,482	102,413	124,458	·960	1·020
0·96	147° 29′	92° 24′	78° 20′	92,554	100,323	121,918	·922	1·042
0·94	140° 6′	89° 56′	76° 24′	90,625	98,233	119,378	·884	1·064
0·92	133° 51′	87° 32′	74° 30′	88,697	96,143	116,838	·846	1·087
0·90	128° 19′	85° 10′	72° 36′	86,769	94,053	114,298	·810	1·111
0·88	123° 17′	82° 51′	70° 44′	84,841	91,963	111,758	·774	1·136
0·86	118° 38′	80° 34′	68° 54′	82,913	89,873	109,218	·740	1·163
0·84	114° 17′	78° 20′	67° 6′	80,984	87,783	106,678	·706	1·190
0·82	110° 10′	76° 8′	65° 18′	79,056	85,693	104,138	·672	1·220
0·80	106° 16′	73° 58′	63° 31′	77,128	83,603	101,598	·640	1·250
0·78	102° 31′	71° 49′	61° 45′	75,200	81,513	99,058	·608	1·282
0·76	98° 56′	69° 42′	60° 0′	73,272	79,423	96,518	·578	1·316
0·74	95° 28′	67° 37′	58° 16′	71,343	77,333	93,979	·548	1·351
0·72	92° 6′	65° 32′	56° 32′	69,415	75,242	91,439	·518	1·389
0·70	88° 51′	63° 31′	54° 50′	67,487	73,152	88,899	·490	1·429
0·68	85° 41′	61° 30′	53° 9′	65,559	71,062	86,359	·462	1·471
0·66	82° 36′	59° 30′	51° 28′	63,631	68,972	83,819	·436	1·515
0·64	79° 36′	57° 31′	49° 48′	61,702	66,882	81,279	·410	1·562
0·62	76° 38′	55° 34′	48° 9′	59,774	64,792	78,739	·384	1·613
0·60	73° 44′	53° 38′	46° 30′	57,846	62,702	76,199	·360	1·667
0·58	70° 54′	51° 42′	44° 51′	55,918	60,612	73,659	·336	1·724
0·56	68° 6′	49° 48′	43° 14′	53,990	58,522	71,119	·314	1·786
0·54	65° 22′	47° 54′	41° 37′	52,061	56,432	68,579	·292	1·852
0·52	62° 40′	46° 2′	40° 0′	50,133	54,342	66,039	·270	1·923
0·50	60° 0′	44° 10′	38° 24′	48,205	52,252	63,499	·250	2·000
0·45	53° 30′	39° 33′	34° 27′	43,385	47,026	57,149	·203	2·222
0·40	47° 9′	35° 0′	30° 31′	38,564	41,801	50,799	·160	2·500
0·35	40° 58′	30° 30′	26° 38′	33,744	36,576	44,449	·123	2·857
0·30	34° 56′	26° 4′	22° 46′	28,923	31,351	38,099	·090	3·333
0·25	28° 58′	21° 40′	18° 56′	24,103	26,126	31,749	·063	4·000
0·20	23° 4′	17° 18′	15° 7′	19,282	20,901	25,400	·040	5·000
0·15	17° 14′	12° 58′	11° 19′	14,462	15,676	19,050	·023	6·667
0·10	11° 29′	8° 38′	7° 34′	9,641	10,450	12,700	·010	10·000
0·05	5° 44′	4° 18′	3° 46′	4,821	5,225	6,350	·003	20·000

COMPARISON OF THE FAHRENHEIT AND CENTIGRADE THERMOMETERS.

Fahr.	Centigr.	Fahr.	Centigr.	Fahr.	Centigr.	Fahr.	Centigr.	Fahr.	Centigr.
°	°	°	°	°	°	°	°	°	°
212	100	158	70	104	40	50	10	- 4	- 20
210·2	99	156·2	69	102·2	39	48·2	9	- 5·8	- 21
210	98·89	156	68·89	102	38·89	48	8·89	- 6	- 21·11
208·4	98	154·4	68	100·4	38	46·4	8	- 7·6	- 22
208	97·78	154	67·78	100	37·78	46	7·78	- 8	- 22·22
206·6	97	152·6	67	98·6	37	44·6	7	- 9·4	- 23
206	96·67	152	66·67	98	36·67	44	6·67	- 10	- 23·33
204·8	96	150·8	66	96·8	36	42·8	6	- 11·2	- 24
204	95·56	150	65·56	96	35·56	42	5·56	- 12	- 24·44
203	95	149	65	95	35	41	5	- 13	- 25
202	94·44	148	64·44	94	34·44	40	4·44	- 14	- 25·56
201·2	94	147·2	64	93·2	34	39·2	4	- 14·8	- 26
200	93·33	146	63·33	92	33·33	38	3·33	- 16	- 26·67
199·4	93	145·4	63	91·4	33	37·4	3	- 16·6	- 27
198	92·22	144	62·22	90	32·22	36	2·22	- 18	- 27·78
197·6	92	143·6	62	89·6	32	35·6	2	- 18·4	- 28
196	91·11	142	61·11	88	31·11	34	1·11	- 20	- 28·89
195·8	91	141·8	61	87·8	31	33·8	1	- 20·2	- 29
194	90	140	60	86	30	32	0	- 22	- 30
192·2	89	138·2	59	84·2	29	30·2	- 1	- 23·8	- 31
192	88·89	138	58·89	84	28·89	30	- 1·11	- 24	- 31·11
190·4	88	136·4	58	82·4	28	28·4	- 2	- 25·6	- 32
190	87·78	136	57·78	82	27·78	28	- 2·22	- 26	- 32·22
188·6	87	134·6	57	80·6	27	26·6	- 3	- 27·4	- 33
188	86·67	134	56·67	80	26·67	26	- 3·33	- 28	- 33·33
186·8	86	132·8	56	78·8	26	24·8	- 4	- 29·2	- 34
186	85·56	132	55·56	78	25·56	24	- 4·44	- 30	- 34·44
185	85	131	55	77	25	23	- 5	- 31	- 35
184	84·44	130	54·44	76	24·44	22	- 5·56	- 32	- 35·56
183·2	84	129·2	54	75·2	24	21·2	- 6	- 32·8	- 36
182	83·33	128	53·33	74	23·33	20	- 6·67	- 34	- 36·67
181·4	83	127·4	53	73·4	23	19·4	- 7	- 34·6	- 37
180	82·22	126	52·22	72	22·22	18	- 7·78	- 36	- 37·78
179·6	82	125·6	52	71·6	22	17·6	- 8	- 36·4	- 38
178	81·11	124	51·11	70	21·11	16	- 8·89	- 38	- 38·89
177·8	81	123·8	51	69·8	21	15·8	- 9	- 38·2	- 39
176	80	122	50	68·2	20	14	- 10	- 40	- 40
174·2	79	120·2	49	66	19	12·2	- 11	- 41·80	- 41
174	78·89	120	48·89	66·4	18·89	12	- 11·11	- 42	- 41·11
172·4	78	118·4	48	64	18	10·4	- 12	- 43·60	- 42
172	77·78	118	47·78	64·6	17·78	10	- 12·22	- 44	- 42·22
170·6	77	116·6	47	62	17	8·6	- 13	- 45·40	- 43
170	76·67	116	46·67	62·8	16·67	8	- 13·33	- 46	- 43·33
168·8	76	114·8	46	60	16	6·8	- 14	- 47·20	- 44
168	75·56	114	45·56	60	15·56	6	- 14·44	- 48	- 44·44
167	75	113	45	59	15	5	- 15	- 49	- 45
166	74·44	112	44·44	58	14·44	4	- 15·56	- 50	- 45·56
165·2	74	111·2	44	57·2	14	3·2	- 16	- 50·80	- 46
164	73·33	110	43·33	56	13·33	2	- 16·67	- 52	- 46·67
163·4	73	109·4	43	55·4	13	1·4	- 17	- 52·60	- 47
162	72·22	108	42·22	54	12·22	0	- 17·78	- 54	- 47·78
161·6	72	107·6	42	53·6	12	- 0·4	- 18	- 54·40	- 48
160	71·11	106	41·11	52	11·11	- 2	- 18·89	- 56	- 48·89
159·8	71	105·8	41	51·8	11	- 2·2	- 19	- 56·20	- 49
								- 58	- 50



ROYAL MICROSCOPICAL SOCIETY.

MEETINGS FOR 1891, at 8 p.m.

Wednesday,	JANUARY	21	*(Annual Meeting for Election of Officers and Council.)*
„	FEBRUARY	18	
„	MARCH	18	
„	APRIL	15	
Wednesday,	MAY	20	
„	JUNE	17	
„	OCTOBER	21	
„	NOVEMBER	18	
„	DECEMBER	16	

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JOURNAL

OF THE

ROYAL MICROSCOPICAL SOCIETY.

APRIL 1891.

TRANSACTIONS OF THE SOCIETY.

III.—*Report on an Earthworm collected for the Natural History Department of the British Museum, by Emin Pasha, in Equatorial Africa.*

By W. Blaxland Benham, D.Sc., Assistant to the Deputy Linacre Professor of Comparative Anatomy in the University of Oxford.

(*Read* 18*th February*, 1891.)

Plates III and IV.

During the month of May in the year 1890, I was invited by Prof. Jeffrey Bell to examine a small earthworm received from Emin Pasha, and collected by him at Karagué in Equatorial Africa. As a superficial examination at the Natural History Museum did not enable me to form any reliable opinion as to the genus of the worm, I asked that I might be allowed to examine it more thoroughly by means

EXPLANATION OF PLATES III. and IV.

Fig. 1.—The worm, natural size, as preserved in spirit. *a*, anterior end. *p*, posterior end.

„ 2.—The posterior end enlarged, to show characteristic diminution in diameter immediately in front of the anus (*p*).

„ 3.—A strip of the body-wall flattened out and mounted permanently to show the arrangement of the setæ and position of the nephridiopores. The lines *V V* and *D D* indicate the ventral and dorsal mid-lines. 1, 2, are the inner or ventral couple of setæ. 3, 4, the outer couple. *np*, nephridiopore.

The shading indicates the relative thickness of longitudinal muscles, which are more abundant ventrally than elsewhere.

„ 4.—One of the setæ, the hooked end being free.

„ 5.—General view of the internal anatomy. The figure is diagrammatic, being composed from the study of the series of longitudinal vertical sections. The nephridia are figured only on the right side.

ca^1, the anterior calciferous glands, that on the right side being in somite IX. and on the left in somite X. ca^2, the second pair of calciferous glands. $ca^2\,l$, the posterior lobe of this gland in somite XII. *g*, gizzard. *œs*, œsophagus, bent upon itself. *n*, nephridia. *pt.n*, peptonephridium, partly hidden by the radiating muscles of the pharynx. *si*, sacculated intestine. *p.gl*, groups of cells forming "pharyngeal glands."

„ 6.—The second pair of calciferous glands, supposed to be seen from behind

of dissection or serial sections. To this Dr. Günther most kindly assented, and to him I beg to express my very hearty thanks for this privilege so courteously granted; to Prof. Bell too, who has allowed me to examine, from time to time, many specimens of earthworms that the Museum has received, my thanks are due. A condition was attached to Dr. Günther's consent, that I should return to him any preparations of the worm which I might have occasion to make. As the worm is a unique specimen this was only just and reasonable, and I readily agreed to it.

The single specimen was of too small a size to dissect, and moreover, such a dissection would not have exhibited, without too great

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(diagrammatic). *ca*², the chief lobe in somite XI. *ca*².*l*, lobe in XII. *i*, cut intestine. *d*, duct of gland opening into intestine.

Fig. 7.—Section of anterior calciferous gland of right side from a longitudinal section. *b.v*, blood-vessels. *e*, lining epithelium of the gland. *l*, lumen. *x*, vacuolated cells in the centre. (Slide VI. *b* 7 *et seq.*)

„ 8.—A section through the posterior calciferous gland and its lobe (*ca*².*l*) showing the more extensive lumen. (Slide XI. *b*.)

„ 9.—A portion of the preceding under a high power. *B.v*, blood-vessels. *ep*, excreting epithelium, with striated protoplasm. *cœ.ep*, vesicular cœlomic epithelium. *m*, muscles in the wall of the gland.

„ 10.—Diagrammatic drawing of transverse section of the pharynx, compiled from longitudinal sections. *gl*, groups of gland cells, constituting a "pharyngeal gland." *m*, rows of muscles, alternating with the glands. *u*, the upper wall. *l*, lower wall of diverticulum (*di*).

„ 11.—A portion of the preceding (*di*, fig. 10) more highly magnified. *di*, the lateral part of the diverticulum. *u*, the upper ciliated epithelium. *l*, the lower, cuticulated epithelium. *m*, muscles.

„ 12.—A group of gland cells from the wall of the pharynx. *gl*, gland cells in strings. *n*, nucleus of one such cell. *m*, muscle-fibres.

„ 13.—Transverse section of the body posterior to the genital region, slightly diagrammatic in so far as the nephridia are shown, with nephridiopore on one side, and setæ. 1, 2, 3, 4, the four setæ on one side. *D.v*, dorsal blood-vessel with intestinal branches. *s.i.v*, subintestinal vessel. *s.n.v*, subneural vessel. *N*, nerve-cord. *n*, nephridium. *f*, its nephrostome. *n.p*, nephridiopore. *B.w*, body-wall. *I.w*, intestinal wall. (Both are represented quite diagrammatically.)

„ 14.—A portion of the intestinal wall to show the three kinds of cells, *a*, *b*, *c*, forming its lining, with *b.v* blood-vessel, *c.m* circular muscles.

15.—The three cells represented isolated as is the case in some of the damaged sections. *a*, ordinary ciliated columnar cell. *b*, goblet cell, with *x*, the secretion. *c*, deeply staining triradiate cell, with spherular secretory contents. *n*, nucleus.

„ 16.—General diagrammatic view of the genital system (immature worm), compiled from examination of longitudinal sections. The alimentary canal is supposed to have been removed. *t*, testis. *f*, funnel of sperm-duct. *s.s*, sperm-sac. *o*, ovary. *od*, funnel of oviduct. *os*, probable ovisac. *n*, nerve-cord.

„ 17.—A portion of a section through the spermiducal funnel, very highly magnified. (Slide VI. *b* 3.)

sp.f, rudimentary sperm-funnel not yet ciliated. *n.st*, nephrostome imbedded in the thickening which will give rise to the sperm-funnel. *b.v*, blood-vessel. *sep*, septum between somites XI. and XII. *m*, muscles of septum.

The arrow points to the position of the internal aperture of the sperm-duct, which can be seen a few sections from this. (Slide VI. *a* 5.) Cf. this drawing with those of Bergh, loc. cit. in text.

destruction of some parts, all that was necessary to ascertain its structure; so that, after making a careful drawing and making all necessary superficial examination, I cut off the first twenty segments of the worm, and after staining this anterior portion, and imbedding it in the usual way, I cut it into a number of consecutive sections by means of a "ribbon microtome."

I made the sections, as nearly as I could, in planes parallel with the median plane of the animal, and they are all arranged in order on the accompanying slides. Unfortunately many of these sections are a good deal torn, and organs therefore displaced; this was due to the dirt and grit in the alimentary canal—a fruitful cause of the imperfection of sections, which is familiar to those who have cut longitudinal sections through earthworms. But a sufficient number of sections are perfect enough for my purpose of identifying the genus to which the worm belongs.

In addition to this series of sagittal sections, I cut a small portion of the next following region of the worm into a number of transverse sections. Further, a small portion of the body-wall is spread out, flattened, and mounted, in order to show the disposition of the setæ and the nephridiopores. The remnant of the worm, together with these preparations and a drawing of its appearance and colour in spirit, was returned to the Natural History Museum.

In the case of the longitudinal sections each slide is numbered with Roman numerals I. to XIII. The number is written at one corner, which is the right top corner when the slide is placed in the proper position. The series starts in each slide at this point, and passes to the left side. That is row *a*. Row *b* in the same way starts at the right side and should be followed to the left.

In my drawings I refer to the sections thus:—IV. *a* 6 indicates the sixth section from the right side along row *a*, on the fourth slide of the series. These slides then can be referred to in order to confirm or contradict my statements.

Description of Eminia equatorialis gen. et sp. nov.

The worm, as will be seen from the following description, is the type of a new genus, to which I give the name *Eminia*. Its specific name refers to the region of Africa in which it was collected. The worm is immature, there being no trace of a clitellum or any other external sexual character.

In colour (in spirit) it is brownish, tending to green in the middle and posterior parts of the body, owing to the partial transparency of the body-wall, and the consequent visibility of intestinal contents. This colouring is shown in the sketch deposited in the British Museum.

The length of the worm is about 2 in.; see fig. 1 which is of the natural size, and represents it coiled as it was in spirit. The

number of segments in relation to the length is very great, being about 190.

The *clitellum* being undeveloped and the *male pores* being invisible no clue to its affinity was afforded by its external character.

The *setæ* are eight in number in each segment, arranged in four couples. The outer couple, where the setæ are close together, is lateral; the inner couple, i. e. that nearer the ventral mid-line, is ventro-lateral (figs. 3, 13) and the setæ are further apart.

If we take as our unit the distance separating the two setæ of the outer or lateral couple, the inferior setal space is represented by 3, the lateral space, between the two couples, is 6; the ventral space between setæ I and I is 6; the dorsal space between setæ IV and IV is 18.

Or written as a formula, $i = 3\,o$ and $L = V = 6\,o$, where i = space between the two setæ of inner couple, o = space between two setæ of outer couple; L means space between inner and outer couples of one side; V = space between the inner couples.

The setæ themselves are small, measuring 0·135 mm., and are sharply hooked at their free extremity (fig. 4).

The *nephridiopores* are visible under a lens, and are placed in a line with the outer couple, between the setæ III and IV (figs. 3, 13).

There are no *dorsal pores*.

The *prostomium* is small and completely dovetailed into the peristomium or buccal somite (as in *Lumbricus*). In the specimen the prostomium was partly hidden, being bent into the mouth.

The anterior 11 somites are much larger than the rest, they are more decidedly brown in colour, have thicker walls, and each is marked with a distinct ridge surrounding the body.

The *anus* is terminal and circular; the circumanal somite is very small; the penultimate and three or four previous preanal somites gradually widen out to attain the normal diameter of the worm (fig. 2).

The Internal Anatomy.—The arrangement of the internal organs was studied by means of longitudinal sections, but the general relations are shown in diagrammatic fashion by figs. 5 and 16.

The *alimentary canal* (fig. 5) consists of the usual thin-walled buccal region which lies in front of the cerebral ganglia in somite III. Immediately behind the latter lies the thick-walled pharynx, occupying somites III and part of IV, though appearing more extensive. The dorsal wall of the pharynx, as is always the case, is thicker than the ventral wall (see fig. 10), and this thickness is due in part to the groups of radiating and other muscle-fibres and in part to groups of gland cells which are arranged in strings between the radiating muscles (see fig. 12).

These gland cells stain very deeply in borax-carmine, owing to the abundance of granules present in them, which almost conceal the round nucleus.

The presence of these "pharyngeal glands" is very frequent in earthworms; and although they are usually regarded as being used in digestion, their communication with the interior of the pharynx has never been recognized; I myself have been no more fortunate than my predecessors.

Another peculiarity in the pharynx, which from my own observations on various genera seems to be very general, but which has received no detailed description, is the following:— The lumen is of different shape in different parts of the pharynx, as Claparède figured some twenty years ago. One of the most constant diverticula is a dorsally placed, flattened, and laterally extended pouch, communicating with the general pharyngeal cavity anteriorly, or sometimes along its whole extent (fig. 10). The epithelial cells of the roof of this dorsal pouch differ from those of the floor; the latter are short, columnar or sometimes nearly cubical cells, with a distinct cuticle and a round nucleus. The cells forming the upper lining of the dorsal pouch are very much longer and narrower; the nucleus is elongated oval, and lies usually near the base of the cell; moreover, these *dorsal cells are ciliated* (fig. 11). This last fact I have observed in several genera, including *Allolobophora, Criodrilus, Allurus,* and others; and am unaware of any previous mention of the fact in earthworms, though a similar condition is met with in *Polygordius,* according to Fraipont, and in *Nais,* where it forms Semper's "branchial region of pharynx." Claparède in his figures of *Lumbricus* represents, distinctly, a cuticle, and the cilia are indeed so closely set as to give the appearance of a striated cuticle. I have in *Allolobophora* sp. examined a teased portion of a living pharynx and have seen the cilia working.

The following region, the œsophagus, is thin-walled, fairly wide, and laterally compressed; in somite V it widens out and leads into the *gizzard.* This organ occupies only *one somite,* the fifth, but it pushes backwards the thick septa which bound posteriorly the fifth, sixth and seventh somites, so that on a casual examination it would appear—especially, probably, on dissection—that the gizzard occupied these somites, but by tracing out the septa, it is sufficiently easy to determine that it occupies but one somite.

Behind the gizzard the tubular intestine (or as it is sometimes called, the post-ventricular œsophagus) commences; it is considerably narrower than the previous regions, the walls are thinner, the epithelium secretes a cuticle, and it is provided with calciferous glands on its course.

The sacculated intestine commences in segment XIII or XIV; it is not at all an easy point to be sure of, as the septa behind the thirteenth and following somites are extremely thin; they are, too, bulged forwards, and are close together, so that the intestine may commence in XIV, or even XV, but I believe XIII is the somite in which the sacculated intestine commences. There is practically no typhlosole. The intestinal epithelium presents (figs. 14, 15),

three different sorts of cells: (*a*) ciliated columnar cells; (*b*) goblet cells with granular contents; and (*c*) peculiar ⊥-shaped cells, which I have not observed in other worms; these cells contain small spherical globules, and stain very much more deeply in borax-carmine than do the other constituents.

Although the dorsal wall is very slightly pushed inwards by the dorsal vessel, in some sections this feeble typhlosole is scarcely recognizable, and I am doubtful whether it is a real structure, or only artificial (fig. 13).

The *calciferous glands* present a peculiar asymmetry. There are two pairs, slightly differing in structure (see figs. 5, 6, 7, 8). The second pair is bilobed externally; the main part occupies somite XI, a smaller lobe lying in somite XII. This hinder pair of glands is symmetrical.

The anterior pair, which are not lobed, are affected by a curious asymmetry; on one side there is gland in somite IX, on the other in somite X (see fig. 5). All these glands communicate with the intestine on its ventral surface (fig. 6). Each gland consists of a sac, the cavity of which is broken up by a large number of trabeculæ, containing blood-vessels, the whole cavity being lined by a *striated* cubical epithelium. The structure of the two glands is somewhat different. The posterior gland has a much more extensive lumen (fig. 8) and numerous thin and incomplete trabeculæ, or lamellæ; whilst in the anterior gland these lamellæ unite (fig. 7) and interrupt the lumen to a greater extent than in *Lumbricus* and other forms, resembling the calciferous gland of *Urobenus*, figured by me in Q. J. M. Sci., xxvii. pl. ix. fig. 43, and the "Chylustaschen" of *Polytoreutus* Mich. The posterior gland with its numerous free infoldings of the wall, resembles more nearly the calciferous glands of *Lumbricus*, the ventrally placed gland of *Eudrilus*,* and the modified wall of *Diachæta Windlei*.† But none of these authors figure the *striation* of the lining cells (fig. 9).

Genital system (fig. 16).—A single pair of *testes* situated in somite XI. and a pair of ciliated funnels in the same somite constitute the only definite male organs. The duct I can trace through septum XI/XII, but no further. A structure, which I take to be the *sperm-sac*, lies in somite XII attached to the septum XI/XII, close to the funnel; it is empty of young or developing spermatozoa, and in fact a lumen is difficult to detect; the wall is made up of small cells, and a network of blood-vessels is present. There is a pair of these structures. I can find no prostate, nor could I detect the sperm-pore.

Of the female organs, I find the *ovary* in the usual somite, XIII; and behind it the funnel of the oviduct, which passes into the next segment and leads into an apparently solid mass of cells, which I take to represent the future ovisac. I can find no spermathecæ.

* Beddard, P.Z.S., 1887, pl. xxxviii. fig. 3.
† Beddard, Q. J. M. Sci., xxxi. pl. xx. figs. 10, 11.

Both the gonads and their ducts are evidently in a very early condition of development, and closely resemble those figured by Bergh in early stages of *Lumbricus.**

The funnels of sperm and oviduct are evidently formed, in the same way as Bergh has described, as a modification of part of the nephridial funnel,† and the cells do not yet bear cilia; the ducts are apparently not yet formed.

I figure (fig. 17) a portion of a longitudinal section through septum XI/XII, showing a normal nephrostome, on one side of which is the commencement of the sperm-funnel; it closely resembles Bergh's fig. 19, if the sperm-funnel were drawn out laterally.

The *nephridia* are present as a pair of large tubes in each segment behind the fifth; each consists of a "narrow tube," with funnel, a "middle tube," and a wide tube as in *Lumbricus*. This nephridium is much shorter than in that genus, and the tube is less convoluted (fig. 13); the muscular duct is relatively greatly developed, and is produced into a cæcum, extending up the side of the intestine nearly to the dorsal vessel. The nephridiopores are in a line with the outer couple of setæ. The anterior segments are occupied by a pepto-nephridium (fig. 5, *ptn*) such as we find in *Urochæta* and other genera. It is a large mass of tubules lying at the side of the pharynx and œsophagus; the tubules have every resemblance to that of an ordinary nephridium, and at least two funnels are present, one in the sixth, the other in the seventh. I have not been able to ascertain whether the duct opens internally to the pharynx, or externally.

As to the *nervous system* and *vascular system* I have nothing characteristic to describe, except the position of the *subneural* vessel, which, instead of being surrounded by the sheath of the nerve-cord, as in *Lumbricus*, is removed from this, and in fact lies in the body-wall (see fig. 13), as Beddard has recently described in *Perichæta*.‡

There are peculiar sacs in VIII and IX with several setæ lying below the calciferous glands in the latter segment, and apparently isolated from the epidermis. I do not know the meaning of these structures.

The *Affinities of Eminia*.—It is "meganephric," non-prostatiferous, octochætous; hence it belongs to one of the three families, *Geoscolecidæ* (mihi), *Rhinodrilidæ* (mihi), or *Lumbricidæ*.§ With the last it cannot be included, owing to the forward position of gizzard, lateral position of nephridiopores, and for other reasons.

From the Rhinodrilidæ it differs in the possession of a *single* pair of testes, and sperm-sacs, although in the position of gizzard, nephridiopores, and nephridial cæcum it resembles some of the members of the family.

* Zeitschr. f. Wiss. Zool., xliv. pl. xxi. figs. 20, 21, 22.
† Cf. also Beddard, Proc. Roy. Soc., 1890.
‡ Q. J. M. Sci., xxx. pl. xxix. fig. 7.
§ Op. c., xxxi. p. 218.

The genera which possess only *one pair of testes and sperm-sacs* —which are the chief characters on which we can rely in the case of the present worm—are *Geoscolex*, *Urochæta*, *Diachæta* (which I have grouped together as a family Geoscolecidæ, separated from the Rhinodrilidæ by the above character, by the separation and alternation of the setæ, and other minor characters).

With these genera *Eminia* shows considerable agreement. In *Diachæta* the testes have the same position as in *Eminia*, in somite XI. The gizzard is in somite VI; a large pair of peptonephridia, resembling those of *Eminia*, have a similar position; but in *Diachæta* (though in *D. Windlei* there are modifications of the œsophageal wall), no distinct calciferous glands occur, nor is the nephridium provided with a "cæcum"; the setæ are moreover characteristically scattered and alternate.

From *Urochæta* and *Geoscolex*, where the setæ are posteriorly scattered and alternate, *Eminia* also differs in the position of testes, in number and position of calciferous glands, and in position of gizzard.

The nephridia of *Urochæta* are unlike those of *Eminia*, which however resemble those of *Geoscolex*, although the peptonephridia of the two are alike. The nephridiopores have the same position in the two genera.

This Central African earthworm is therefore a new genus; it agrees more closely with the *Geoscolecidæ* than with the *Rhinodrilidæ*, and perhaps serves to connect the two families. It is difficult to say—till we can obtain fully developed specimens—to which genera *Eminia* is most nearly allied. I thought at an early stage of my examination of the worm that *Eminia* might be a young stage of *Urochæta*, in which the characteristic arrangement of the setæ at the posterior end of the body had not yet been acquired, but a comparison of the nephridia and their funnels and other structures showed me that the two are distinct.

It is most unfortunate that this is the solitary specimen collected; if a few others had been collected at the same time we might have been able to fill in the gaps which at present must remain as such.

SUMMARY

OF CURRENT RESEARCHES RELATING TO

ZOOLOGY AND BOTANY

(*principally Invertebrata and Cryptogamia*),

MICROSCOPY, &c.,

INCLUDING ORIGINAL COMMUNICATIONS FROM FELLOWS AND OTHERS.*

ZOOLOGY.

A. VERTEBRATA:—Embryology, Histology, and General.

a. Embryology.†

Fate of the Human Decidua reflexa.‡—Prof. C. S. Minot has arrived at some conclusions in regard to the well-known but imperfectly understood disappearance of the decidua reflexa. The view most generally accepted has been that it fused about the fifth month with the decidua vera, and that accordingly the layer of decidua nearest the chorion during the latter half of pregnancy represents the decidua reflexa. Minot has studied normal uteri of two, three, five to six, and seven months' gestation. These show that at two months the decidua reflexa is undergoing hyaline degeneration, that at three months the degeneration is considerably more advanced, and that by the sixth and seventh months the reflexa can no longer be found. Therefore the theory seems justified that the reflexa degenerates and is completely absorbed. This is the more probable, since recent investigations have shown that in many placental mammals there is an extensive pseudo-pathological destruction of the mucosa uteri during gestation. As to the cause of the degeneration, Prof. Minot simply regards it as the result of a reflex nervous activity,

Transplantation and Growth of Mammalian Ova within a Uterine Foster-mother.§—Mr. W. Heape records an experiment by which it is shown that it is possible to make use of the uterus of one variety of rabbit as a medium for the growth and complete development of fertilized ova of another variety of rabbit. Two ova were taken from an

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

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

‡ Anat. Anzeig., v. (1890) pp. 639-43 (1 fig.).

§ Proc. Roy. Soc. Lond., xlviii. (1891) pp. 437-8.

Angora doe rabbit which had been fertilized by an Angora buck thirty-two hours previously: the ova were, at the time, divided into four segments. They were immediately transferred into the upper end of the fallopian tube of a Belgian hare doe rabbit which had been fertilized three hours before by a buck of her own breed. When the Belgian doe gave birth she produced six young, four of which were like herself and her mate, and two of which were undoubted Angoras. So far as this single experiment goes it does not favour the view that a uterine foster-mother has any effect on her foster-children, or that the presence and development of foreign ova in the uterus of a mother affects the offspring of the mother born at the same time.

Maturation of the Ova of Elasmobranchs.*—Prof. N. Kastschenko has investigated the process of maturation in the ova of *Pristiurus melanostomus*, *Torpedo ocellata*, and *Scyllium canicula*. One polar body is formed by karyokinesis, while the ova are still in the ovary; a second may be formed subsequently, perhaps at the time of fertilization. No extrusion of portions of the germinal vesicle was observed, but there is probably some absorption of nuclear material by the yolk.

Early Stages in Development of Elasmobranchs.†—Prof. A. Schneider, who has made a study of the early stages of the development of Elasmobranchs, reports that the tissue of the embryo consists of protoplasm with nuclei; the caudal portion consists of mesoderm and ectoderm. In the mesoderm the protoplasm becomes collected around the nuclei, and the cell-territories give off processes and form a connected stellate tissue, In the ectoderm the protoplasm remains continuous; that layer is connected with the mesoderm by stellate tissue.

The mesoderm gives rise to the dorsal medulla and brain as well as to the primitive vertebræ and lateral plates; in the anterior region the mesoderm is formed from the middle line of the outer layer, and the ectoderm appears at the sides. The primitive vertebræ are from the first connected by the motor-nerves with the dorsal medulla; they and the lateral plates are at first connected, but afterwards become separated. The connective tissue and the muscles are developed from the lateral plates and primitive vertebræ, the latter giving rise to the longitudinal muscles, and the former to the enteric and cardiac musculature, the fin-muscles, the musculature of the gills and jaws, and to the vessels.

Yolk-sac of Young Toad-fish.‡—Prof. J. A. Ryder has studied the functions and histology of the yolk-sac of *Batrachus tau*. Unlike other fish-larvæ, the young do not escape from the egg-membrane immediately after its rupture, but continue to adhere to it by a discoidal area, and are thus indirectly attached to foreign bodies. The cellular membrane which covers the lower pole of the yolk-sac is much thickened as compared with the rest of the outer wall of the yolk. The thickening is due to the peripheral ends of the cells of the epidermis being prolonged in the form of a homogeneous and almost vitreous-looking material.

The whole of the free surface of the epidermis covering the yolk-sac is

* Zeitschr. f. Wiss. Zool., l. (1890) pp. 428-42 (1 pl.).
† Zool. Beitr. (Schneider), ii. (1890) pp. 251-66 (1 pl.).
‡ Proc. Acad. Nat. Sci. Philadelphia, 1890, pp. 407-8.

studded with scattered goblet or mucus-secreting cells. The yolk-sac is also remarkable for the presence of a layer of smooth muscular fibres under the epidermis, which appears to originate from the splanchnic mesoblast. Nothing of this kind seems to be known in the yolk-sac of any other young fish. There is no reason for supposing, as some ichthyologists have, that the fixation of the young is a voluntary action.

The Origin of Blood from the Endoderm.*—Herr H. K. Corning describes peculiar strands of cells in the endoderm of embryos of *Tropidonotus natrix* at the gastrula-stage, and inclines to think that they are connected with the endodermic formation of blood. The same appearances were seen in the gastrula-stage of *Lacerta agilis*, but with less distinctness. Herr Corning notices that Kupffer, in 1882, described similar strands in the gastrula-stage of *Coluber Æsculapii*, and interpreted them as vascular structures, but traced them to a "parablastic" origin, or, in other words, to the much-discussed yolk-nuclei.

β. Histology.

Streaming Movements of Protoplasm.†—Prof. C. Frommann maintains that the movements of fluids in what may be called the "artificial cells" made by Quincke and by Bütschli are in many ways different from those exhibited by living matter. Quincke sought to explain streaming movements by supposing a periodic distribution of albuminoid soap along the surface of the plasma, but this would not explain the occasional coexistence of streams in opposite directions within the cells of *Tradescantia* or *Urtica*, nor the occasional sudden stoppage or even reversal of movement, nor several other characteristics of protoplasmic movement. As to the relations between protoplasmic streaming and that of fine foam globules, e. g. those of Bütschli's emulsions, &c., it must be remembered that the former is retarded and stopped by cutting off the supply of oxygen, which is sufficient evidence of the dependence of the movement on metabolism. In regard to Bütschli's theory of the predominantly vacuolar structure of protoplasm, Frommann admits what he has previously demonstrated in detail, that there are many illustrations of vacuolated protoplasm, that in many cases the structure is rather that of a broken than of a complete network, that framework and network may result from the modification of vacuoles with originally intact walls, but he urges, as he may naturally do with some confidence, that in many cases apart from the presence of vacuoles there is a genuine network.

Cell-Structure.‡—Dr. K. C. Schneider finds that both the protoplasm and the nucleus of cells have a homogeneous framework, the bars of which are directly connected through the nuclear membrane. This framework consists typically of looped fibres of equal thickness, which have the power of uniting with one another and so giving rise to membranes. This formation of membranes may be very well seen in cells rich in vacuoles, such as the eggs of *Ascaris megalocephala*. When the vacuolation is very considerable almost all the free fibres may pass into

* Arch. f. Mikr. Anat., xxxvi. (1890) pp. 516–27 (1 pl.).
† Anat. Anzeig., v. (1890) pp. 648–52, 661–72 (4 figs.).
‡ Zool. Anzeig., xiv. (1891) pp. 44–6, 49–50.

membranes and a honeycomb-like structure is obtained. The closer the fibres the more refractive the membrane.

The common characters of the intermediate mass of the protoplasm and nucleus are shown by the fact that, if the nuclear membrane be destroyed or the nuclei have no membrane, no differences of any kind can be seen in the apparently homogeneous ground-substance. The most essential difference between protoplasm and nucleus lies in the presence of chromatin in the latter. By this term chromatin we are to understand a substance which stains with numerous colouring matters, and in distribution varies considerably. The agglomeration of chromatin-grains into small masses is of the highest interest, as it throws light on the morphological significance of nucleoli. The origin of nucleoli can be very well observed in *Sphærechinus*. Sometimes there are seen spherical parts of the framework which contain regularly distributed chromatin-grains; no membrane can be observed. Other nucleoli already show a membrane, and the framework, though as closely meshed as in the first, is not so distinctly recognizable. In a third case, though certainly present, the framework is difficult to see, and there is here and there a tendency to the formation of internal concentric membranes. Finally, when the nucleoli are completely developed, there is a highly refractive membrane. Just as the nucleoli are formed from chromatin-grains, so they may again be resolved into them, for the membranes may break up again into fibres.

The author has succeeded in demonstrating the identity of the bars of the framework with spindle-fibres. The contractility of the former may be shown by the mode of transportation of spermatozoa in, for example, *Strongylocentrotus* from the periphery to the centre. Before contracting, part of the fibre elongates, and perhaps breaks at a point of attachment.

Two New and Undescribed Methods of Contractility in Filaments of Protoplasm.*—Prof. J. A. Ryder has investigated the peculiar phenomena of contractility presented by the stalk of *Vorticella* and the body of *Trypansoma Balbianii*. The true state of things in the former has never yet been adequately described. The muscular filament of *Vorticella* passes downwards through its sheath in a spiral manner, and is only in contact along a spiral line with the inside of the transparent investing sheath. The filament thus makes eight or nine complete turns within its sheath, which is itself not in contact with the spiral muscular filament, except along the already mentioned spiral line. If, then, this spiral line of contact is in turn traced upon the muscular filament it will be found to describe a spiral around the latter. To fully satisfy the mechanical conditions of the problem, it is necessary to assume that the contractile filament of *Vorticella* is composed of alternating and superposed discs of singly and doubly refractive plasms. Observations of mounted preparations of *Carchesium polypinum* show that the coiled parts of the muscular filament are actually composed of discoidal elements, such as are met with in ordinary muscular-fibre. Further study showed that the discs of anisotropic matter are in contact along the concave or inner side of the coils, and not in contact on the outer

* Proc. Acad. Sci. Philadelphia, 1891, pp. 10-12.

or convex sides or faces of the coils, where a wedge-shaped mass of isotropic material seems to be interposed between the outer edges of the successive anisotropic discs.

While we have in *Vorticella* unequally contracting discs fixed in a spiral order, *Trypanosoma Balbianii* exhibits a rapid reversal of the spiral in a dextral or a sinistral direction; the contractile discs (not, however, yet observed), are supposed to have waves of contraction revolving in them.

Suitable Object for Study of "Direct" Nuclear Division.*—Prof. H. Hoyer found the pulmonary sacs of two frogs full of a large number of specimens of *Rhabdonema nigrovenosum* which he preserved in strong alcohol; several specimens were afterwards stained in an alcoholic solution of borax-carmine for 24 hours, then extracted in strong alcohol to which 1 per cent. hydrochloric acid had been added, for one hour; they were next placed in glacial acetic acid for a quarter of an hour, then in a mixture of equal parts of glacial acetic and creosote, and afterwards in pure creosote; they were then teased and the particles mounted in a concentrated solution of Canada balsam in creosote. The large, polygonal, very granular, but only feebly stained epithelial cells of the enteric canal were seen to show some very remarkable appearances. Most of them contained a single large, rounded, sharply limited, darkly granulated nucleus, ·0014–·025 mm. in size, These nuclei were coloured intensely red, and each contained a very deeply stained, large, round nucleolus which was inclosed by an uncoloured, relatively broad, clear area; this last is probably an artificial product due to preservation in alcohol. Various cells of different kinds were found among those just described, and some of these had three to four nuclei of various sizes.

γ. General.

Biological Terminology.†—Prof. T. J. Parker accepts Mr. Harvey Gibson's criticism of his term blastobium for asexual generations, and proposes to replace it by agamobium, which will correspond with gamobium, Prof. Parker's already proposed term for sexual generations. Prof. Parker thinks that we must be thorough in our reforms and must give up the erroneous use by botanists of the term ovary; he proposes to speak of it as the venter of the pistil. Just as Haeckel and others have suggested some useful terms for the more important embryonic stages of animals, so Prof. Parker suggests some for similar stages in plants. The stage in mosses and vascular plants next important after the oosperm-stage is that in which the embryo consists of a mass of cells nearly or quite undifferentiated; to this the already formed name of polyplast may be applied. In vascular plants there is another stage of importance—that in which there is formation of a cotyledon and of the primary roots; this it is proposed to call the *phyllula*.

Anabiosis.‡—Prof. W. Preyer has for the last twenty-five years interested himself in anabiosis—the revival of lifeless organisms and parts of organisms, after a state which differs from apparent death in the total suspension of all the functions, and from death itself in the retention of

* Anat. Anzeig., v. (1890) pp. 26–9.
† Nature, xliii. (1890) pp. 141–2.
‡ Biol. Centralbl., xi. (1891) pp. 1–5.

the potency of living. He recalls some of his experiments with frozen frogs, in which the circulation and other vital movements cease, but which revive when thawed, provided the internal temperature has not gone below a minimum of − 2·5° C. The same is true of the excised heart. Prof. Preyer also relates some of his observations on the revival of desiccated rotifers and Tardigrades, and maintains that there is no *vita minima* in such cases, but a genuine lifelessness, from which the organism may recover.

Chlorophyll in the Animal Kingdom.*—M. E. Penard discusses some of the reputed cases of the presence of chlorophyll in animals, and comes to the conclusion that, in the actual state of our knowledge, we cannot consider chlorophyll as ever being a direct product of animal protoplasm. He does not deny that, in some of the Flagellata, chlorophyll exists in chromatophores of endogenous origin, but such forms present other characters which are vegetable and not animal in character.

Origin of the Liver.†—Dr. T. W. Shore has been led by his investigations to the now recognized view that the "liver" of invertebrates is not morphologically the same as that of vertebrates. It is the gland of the mid-gut, and when present, has essentially the same nature in all; it is composed of cæcal pouches, which are lined by secreting epithelium and surrounded by connective-tissue membranes. The liver of vertebrates is made up of a network of tubules, interlacing with a network of blood-capillaries and with no basement membrane separating the blood-capillaries from the liver-cells.

The "liver" of invertebrates is essentially a gland, secreting a digestive fluid containing ferments; that of vertebrates is primarily an organ of nutrition for the embryo, and has been adapted to perform similar functions in the adult; in its evolution it is intimately associated with the absorption of the food-yolk of the egg. The pancreas of vertebrates is somewhat similar in structure and functions to the "mid-gut gland" of invertebrates, but we cannot certainly say whether or not the two organs are morphologically equivalent.

Fauna of Amber.‡—Herr R. Klebs has had the opportunity of examining several hundred thousand pieces of amber. In it, as is well known, various animals, largely insects, became entangled as the amber solidified. The order most numerously represented is that of the Diptera, and of some of the genera of these there are numerous species—*Chironomus* being represented by at least forty, and *Ceratopogon* by twenty-six. All the groups of Hymenoptera except the Braconidæ and Craniidæ are represented, and forty-nine of the seventy-five families of Coleoptera. Of the Orthoptera the Blattidæ are the most numerous. *Campodea* has not been certainly detected. Termites are numerous, and there are about one thousand specimens of Microlepidoptera.

The larger number of Arachnids imbedded were various forms of Spiders, but there are also many Mites. Only one true Scorpion has been found. As may be supposed, the bulk of the Crustacea are Isopods.

* Arch. Sci. Phys. et Nat., xxiv. (1890) pp. 638-48.

† Journ. of Anat. and Physiol., xxv. (1891) pp. 166-97 (1 pl.).

‡ Biol. Centralbl., x. (1890) pp. 444-8. See Ann. and Mag. Nat. Hist., vi. (1890) pp. 486-91.

Nematoid worms were rarely found. Only twelve specimens of Mollusca are recorded, and parts of Vertebrates—such as feathers or hair—are very rare. The nearest allies of the amber fauna are, to-day, found in North America and Eastern Asia.

B. INVERTEBRATA.

Notices of Entozoa.*—Prof. J. Leidy draws attention to the discovery in *Simia satyrus* (the Orang) of *Ascaris lumbricoides* and *Trichocephalus dispar*, which are common parasites of Man. With them were found examples which are provisionally placed in the genus *Filaria* and called *F. (?) primana* sp. n. *Ascaris diacis* from the body-cavity of *Quiscalus quiscala* and *Atractis (Ascaris) opeatura* from the Iguanid *Cyclura baelopha* are new. About a pint measure of *Trichocephalus affinis* was taken from the large intestine of the Bactrian Camel. Several dozen of *Cheilospirura uncinipenis* were found in the gizzard of *Rhea americana*. *Trichosomum ? tenuissimum* sp. n. was found imbedded in the liver of a mature Brown Rat. A dozen females of *Echinorhynchus pellucidus* were found attached to the lining membrane of the intestine of a whale, *Mesoplodon sowerbiensis*; *E. paucihamatus* sp. n. was frequent and abundant in the small intestine of the Black Bass (*Micropterus nigricans*). Five new species of *Distomum* are recorded, as are two new Cestodes. *Pentastomum proboscideum* is reported from *Coluber constrictor* and the Skunk (*Mephitis mephitica*).

Mollusca.

a. Cephalopoda.

Development of Chromatophores of Octopod Cephalopoda.†—M. L. Joubin has been able to study the development of the chromatophores in the Argonaut and the Octopus. In the embryo of the former the skin is composed of an ectodermal epithelium, which covers a loose mesodermal connective tissue. In the dorsal interocular region one may best see scattered ectodermal cells becoming longer than those around them; they then gradually sink into a kind of funnel-shaped depression, taking with them the neighbouring cells. The large cell is destined to form the essential part of the chromatophore; as it becomes very large its protoplasmic contents are divided into two layers. This cell is, later, only attached by a narrow surface to the invaginated ectodermal cells, and finally becomes free; later on it loses its spherical form and becomes a biconvex lens.

Meantime, changes have been going on in the mesodermal cells; below the invagination they are disposed by five or six, in a circle, but they soon increase to twenty and form a larger circle; in form they are ovoid and elongated. The edge of the ectodermal cell then comes into contact with this crown of ovoid cells and the chromatophore is formed. The accessory mesodermal parts at first resemble muscular fibres, but later on become connective. The nerve-endings in each chromatophore can be shown in a living animal by a special preparation of methylene-blue. The cutaneous nervous plexus with each fibre ending in a slight swelling can then also be seen.

* Proc. Acad. Nat. Sci. Philadelphia, 1890, pp. 410–8.
† Comptes Rendus, cxii. (1891) pp. 58–60.

γ. Gastropoda.

Origin and Development of Central Nervous System in Limax maximus.*—Miss Annie P. Henchman, who has made a study of this subject, has arrived at the following conclusions. The whole of the central nervous system arises directly from the ectoderm. The cerebral ganglia partly arise as a pair of true invaginations, one on each side of the body in front of the pleural groove and behind and below the bases of the ocular tentacles. During development the neck of each invagination becomes a long, narrow, tube-like structure, which remains open throughout the period of embryonic life. The chief part of these ganglia is formed from cells which are detached at an early period from the deep ends of their cerebral invaginations, or from adjacent ectoderm; the portions which persist as the walls of the infoldings finally form distinct lateral lobes of the brain.

All the other ganglia originate by cell-proliferation from the ectoderm without invagination. The ganglia arise separately, and with the exception of the abdominal and pallial ganglia, in pairs, one on either side of the body. They become connected with each other by the outgrowth of nerve-fibres.

In advanced stages the central nervous system consists of five pairs of ganglia and an azygous ganglion, which together form three complete rings surrounding the œsophagus.

If a series of sections be examined from behind forwards there are first seen the paired pedal ganglia, which lie under the radular sac, and are joined to each other by an anterior and a posterior commissure. Behind these there is an abdominal ganglion, which lies a little to the right of the median plane. A pair of visceral ganglia occupies the posterior angle formed by the outgrowth of the radular sac from the œsophagus; they are separated by the abdominal ganglion, whence connectives pass to them. There then follows a pair of pleural ganglia which are not joined by a commissure, and do not give off nerves; they are only united by means of connectives to the pedal, visceral, and cerebral ganglia of their own sides. Next in front comes a pair of cerebral ganglia with their supra-œsophageal commissure, and with connectives to the pleural, pedal, and buccal ganglia. And, lastly, there is a pair of buccal ganglia.

The paper concludes with a critical notice of the work of preceding observers.

Pericardial Gland of Gastropoda.†—Prof. C. Grobben gives an account of the pericardial gland, which is found in so many Gastropods; it is derived from the epithelium of the secondary body-cavity, and is closely connected with the blood-vascular systems. After describing the anatomical details of the organ in various Gastropods belonging to different groups, the author points out that the relations of the organ to the blood-vascular system are very similar to those which obtain in Cephalopods and Lamellibranchs; but the epithelial cells are nearly always flat, and no striation or formation of concretions is to be observed. Although, therefore, there is no evidence from the structure

* Bull. Mus. Comp. Zool., xx. (1890) pp. 169–208 (10 pls.).
† Arbeit. Zool. Inst. Wien, ix. (1890) pp. 35–56 (1 pl.).

of the pericardial cells that the organ in question has an excretory function, the author does not doubt that the cells are excretory. The flattened form is well adapted to the outpouring of fluid, and the student need only be reminded that there is pavement epithelium in the Malpighian bodies of the Vertebrate kidney.

Another argument in support of this view is afforded by the fact that the gland is best developed in the Opisthobranchiata. These forms have generally a very large ciliated renal funnel, the colossal cilia of which are capable of producing a powerful stream, and so must effect great suction on the pericardial fluid. As no concretions are to be observed in the cells, and as they do not stain when carmine is injected, it is probable that water alone is excreted by these glands.

When we come to consider the morphology of the pericardial gland of the Mollusca, we observe that the organ is not always developed in the same place or in the same way. In Lamellibranchs the glands may take their origin from the pericardial investment of the auricle, and in others from the anterior angle of the pericardium. Among the Gastropoda the organ is borne by the auricle in the Prosobranchiata, while in the Opisthobranchiata there are very various spots at which the organ may be developed, and the same is the case also with Cephalopods.

For Gastropods, as for Lamellibranchs, the oldest pericardial glands appear to be the atrial, and such are seen in the Prosobranchiata. The variety of positions occupied by the gland in Opisthobranchs is probably due to independent acquirement of these new positions, and such glands should be recognized as secondary.

Everything seems to show that the pericardial gland is an important organ in Mollusca. The extent of its development may stand in inverse relation to that of the cœlom, and it may have some relation to the quantity of water needed by the animal.

Vision of Pulmonate Gastropods.*—M. V. Willem has made a number of observations on the vision of snails, slugs, and other pulmonates, which has led him to the following conclusions:—They have a well-developed tactile sense, and are able to detect slight shocks of the ground on which they are supported, and slight movements of the surrounding medium. The terrestrial forms see very badly, and direct themselves chiefly by means of their olfactory and tactile sensations. They have a confused image of large objects at the distance of about a centimetre, but they do not distinguish at all clearly the forms of objects beyond a distance of one or two millimetres. The aquatic Pulmonata do not see distinctly at any distance whatever. The Mollusca do not seem to have that special power of seeing movements which has been demonstrated in Arthropods. The reaction to light varies, different species of snails and slugs being some fond of, and others fearful of light. The dermatoptic powers vary in various species.

δ. Lamellibranchiata.

Crystalline Style.†—Prof. F. E. Schulze does not believe that this consists of reserve-material, as Hazay and Hasloff have maintained. In fact, histological examination shows that it is an epithelial secretion,

* Comptes Rendus, cxii. (1891) pp. 247-8.

† SB. Gesell. Naturf. Freunde, 1890, pp. 42-3.

and the suggestion of Barrois that it serves, along with the gelatinous layer in the stomach, to protect the walls of the gut by surrounding sharp particles with mucus, is accepted by Schulze as most probable. He compares its functions to that of the epithelial glands which lie near the internal apertures of the gill-clefts in Batrachian larvæ.

Renal Function of Acephalous Mollusca.*—M. A. Letellier has investigated the renal function in *Pecten* and *Cardium*. He finds that the organ of Bojanus gets rid of excess of water, urea, and various neutral nitrogenous bodies and phosphates, as well as, accidentally, uric acid. The organ of Keber (gland of Grobben) extracts from the blood the acid it contains; in both the forms studied the acid was hippuric acid.

Hermaphrodite Lamellibranchs.†—Prof. P. Pelseneer has continued ‡ his studies on the hermaphroditism of certain Lamellibranchs, and now asserts the existence of an entire group exhibiting hermaphroditism. Since describing *Lyonsiella* and *Poromya* he has made investigations as to *Thracia*, *Lyonsia*, *Clavagella*, *Myochama*, and *Cuspidaria*; and he now states that no form of the Anatinacea or Septibranchiata yet studied has been shown to have the sexes separate. We may conclude that they are hermaphrodite, but the male and female gonads separate—an arrangement not known in any other Mollusc. This disposition of parts does not certainly indicate a condition once common to the whole class, as Gegenbaur believes, for all the hermaphrodite Lamellibranchiata are specialized, while the most archaic forms (the Protobranchiata) are not only diœcious, but have never presented an example of such partial hermaphroditism as may be sometimes seen in the Frog or the Herring.

Otocysts of Nuculidæ.§—Prof. P. Pelseneer shows that the Lamellibranchiate Nuculidæ have, at all ages, otocysts which communicate freely with the exterior, and they are the only known Mollusca in which this arrangement is found. The possession of this archaic character confirms the opinion several times expressed by the author that the Nuculidæ are the most primitive of existing Lamellibranchs. In addition to the evidence afforded by the gills, the nervous system and the renal and generative organs, there are other points which Dr. Pelseneer promises to communicate later on.

Molluscoida.

a. Tunicata.

Embryonic Development of Pyrosoma.‖—Prof. W. Salensky states that the egg of *Pyrosoma* is meroblastic. Before fertilization a certain number of cells make their way out from the follicular epithelium; these may be known as calymmocytes. During segmentation the calymmocytes make their way in between the blastomeres and take part in the formation of the body of the embryo; they undergo a considerable change in their protoplasm and nuclei. The differentiation of the germinal layer commences with the division of the segmented germ into an

* Comptes Rendus, cxii. (1891) pp. 56–8.
† Zool. Anzeig., xiv. (1891) pp. 5–8. ‡ See this Journal, 1890, p. 448.
§ Zool. Jahrb. (Abth. f. Anat. u. Ontog.), iv. (1890) pp. 501–4.
‖ T. c., pp. 425–77 (3 pls.).

upper and lower layer; the former gives rise to the ectoderm, and the latter to the mesoendoderm. In the latter, before further differentiation, there appear three series of cavities—those of the cœlom and of the notochord.

The ectoderm gives rise to the nerve-ganglion, which is a thickening, and to the two peribranchial tubes, which are invaginations of the ectoderm. These tubes become, in the course of development, separated from the ectoderm, grow forwards as well as backwards, and do not till later become connected with the independently formed cloacal orifice. Of the two mesodermal tubes, which are at first equally developed, the right alone continues to grow, and becomes the pericardial sac. The left tube breaks up into cells, which either remain separate or (possibly) take part in the formation of the cellular zone which surrounds the germinal disc.

Sense-organ of Salpa.*—Mr. A. Bolles Lee gives an independent account of an organ imperfectly figured and described in Russian by Ussow in 1876. In *Salpa mucronata* there are two of these organs; they are end-organs of a recurrent twig of the third nerve, and are symmetrically placed on either side. In a living specimen the organ may be seen to consist of a stem terminating in a bulb, which is surmounted by a delicate hyaline claviform appendage. The stem is a cellular tube formed by a process of the inner mantle.

In good preparations the bulb may be seen to be composed of a central tuft of sense-cells and a surrounding calyx of supporting cells; the latter varies a good deal in form. The minute details of structure are described, and the author sees much that is plausible in the view that the organ is either a taste-bulb or was one once. But on the other hand, a little reflection shows that while the *Salpa* has in its cellulose mantle a highly watery and highly hygrometric jelly, it has in this organ one whose shape must be affected by change in the density of the circumambient water; these changes would pull on or relax the sensory hairs of the organ, and it, probably, is a hydrometric apparatus.

β. Bryozoa.

Cristatella.†—Mr. C. B. Davenport has investigated the origin and development of the individual in this colonial Bryozoon. He finds that most individuals give rise to two buds, one of which forms a new branch, while the other continues the ancestral branch. The median buds migrate to a considerable distance from the parent polypide before giving rise to new buds. Descendants from common ancestors, equal in age, are arranged similarly in the same region of the colony. New branches are formed on either side of ancestral branches.

The greater the difference in age between the youngest and the next older bud, the greater the distance between the points at which they begin to develope. In typical "double buds" both polypides arise from a common mass of cells at the same time. From the neck of old polypides a stolon-like process of cells is given off to form median buds.

The alimentary tract is formed by two evaginations of the bud, and

* Quart. Journ. Micr. Sci., xxxii. (1891) pp. 89–97 (1 pl.).

† Bull. Mus. Comp. Zool., xx. (1890) pp. 101–52 (10 pls.).

while one forms the œsophagus, the other gives rise to the stomach and rectum. On the fusion of the blind ends of these two pockets a continuous tube is formed. The central nervous system arises as a shallow pit in the floor of the atrium; this pit becomes closed over by a fold of the inner layer only of the polypide, which thus forms a sac, the walls of which become the ganglion. The kamptoderm (Kraepelin), or funicular sheath of Allman and Nitsche, is formed by the conversion of the columnar epithelium of the two layers of the wall of the atrium into pavement epithelium. The funiculus arises from amœboid cells derived from the cœlomic epithelium. The wall of the colony grows by cell-proliferation at its margin.

The budding of *Cristatella* presents conditions transitional between direct and stoloniferous budding; this genus differs from *Alcyonella* in that the tip of the branch grows independently of the polypides. Each of the layers of the younger bud arises from a part of the same cell mass as that which gave rise to the corresponding layer of the next older bud. The digestive epithelium and the nervous tissue are both derived from one and the same layer of cells, the inner layer of the bud. The alimentary tract of a young *Cristatella* is similar to that of a young endoproctous Bryozoon. The author does not agree with Harmer in saying that the ganglion of the Phylactolœmata arises exactly as in the Endoprocta.

The circumoral region of the ring canal of *Cristatella* is in free communication with the cœnocœl in all stages of development, and is not, as Kraepelin maintains, closed. The two arms of the lophophore arise independently of each other. The ancestral Bryozoon probably possessed a U-shaped row of tentacles which encircled the mouth in front, and ended freely behind. The tentacles near the mouth are, phylogenetically, the oldest. The epistome arises as a fold continuous with the wall of the œsophagus below and the floor of the atrium above, and it communicates with the cœnocœl by means of the epistomial canal. The migration of the funiculus is probably assisted by amœboid cells. The origins of the retractor and rotator muscles migrate along the radial partitions from roof to sole; the separation of the two muscles is secondary and due to the separation of their points of insertion. The disintegration of the neck of the polypide is begun by a metamorphosis of the protoplasm of its cells; the metamorphosed cells break away and leave the atrial opening. That part of the body which lies round the atrial opening arises by proliferation of cells derived from the neck of the polypide. The ectodermal cells become metamorphosed by an intercellular secretion of small gelatinous balls which fuse; the contents of more than one cell often fuse into a single large mass.

Arthropoda.

a. Insecta.

Ontogeny of Insects.*—Dr. E. Urech has made a physical and chemical analysis of the urine of a large number of species of Butterflies, and has discovered a close relation between its pigments and those which colour the wings of Lepidoptera in general. The first urine is alone

* Arch. Sci. Phys. et Nat, xxiv. (1890) p. 526.

pigmented and the fluid emitted subsequently is entirely colourless. *Pieris brassicæ* has a white, and *Vanessa urticæ* an intensely red pigment. As the blue and violet of Butterflies are colours produced by interference, there is nothing astonishing in the fact that these colours are not seen in the urine. The colour of insects about to leave the chrysalis stage is not the same in all; it is most often yellow of varying degrees of intensity; in many species of *Bombyx* it is pale, but of a deep hue in *Vanessa*. The blood of *Deilephila euphorbia* is coloured an intense olive-green, and that of *Cossus ligniperda* is pale yellow.

Life-history of Emenadia.*—M. A. Chobaut has been able to follow the life-history of *Emenadia flabellata*. The eggs are laid in the soil in mid-July, and are hatched during the first days of August, when the nest of the solitary wasp *Odynerus* is being provisioned. The minute larva climbs into such a nest, establishes itself in a cell, and becomes eventually an internal parasite in the young wasp. Not till the beginning of June in the following year does it appear again on the surface as an external parasite. It soon makes an end of its victim, pupates in mid-June, and is ready to pair early in July. The primary larva, which seeks actively for a host, has legs, antennæ, and cuirass-like armature. The second form of larva, which possesses and devours its host, has no legs, nor antennæ, nor protective plates. The species of *Emenadia* are parasitic on solitary wasps (*Odynerus*, *Eumenes*, &c.) much in the same way as *Rhipiphorus paradoxus* is on certain social wasps (*Vespa germanica* and *V. vulgaris*). In their larval dimorphism and temporary or persistent endoparasitism, the Rhipiphoridæ connect the vesicant beetles with the *Strepsiptera* or *Stylopidæ*.

Function of the Antennæ in Myrmedonia.†—Herr E. Wasmann has experimented with various species of *Myrmedonia*, small beetles which insinuate themselves as unwelcome guests of the ant *Lasius fuliginosus*. The latter, though soft-skinned and slow, and thus liable to be preyed upon by the beetles, who eat both adults and brood, hunts the robbers with persistence. Wasmann's experiments lead him to believe that the antennæ of *Myrmedonia* are not so important in seeking for food as in detecting hostilely excited ants. The detection of food at a distance is probably in greater part at least due to the palps, but these are too small to extirpate for crucial experiment. Those without feelers have a better appetite, probably because they are no longer troubled by apprehensions of approaching ants.

The Spermatozoa of Coleoptera.‡—Dr. E. Ballowitz continues his study of the minute structure of spermatozoa. In previous papers, some of which have been recorded in this Journal, he has shown that the contractile part of the spermatozoa of mammals, birds, reptiles, amphibians, and fishes, and notably the so-called "undulatory-membrane" or fringe accompanying the axial filament of the tail—consists of or contains very fine fibrils to which the contractility is probably due. Prof. V. Graber §

* Comptes Rendus, cxii. (1891) pp. 350–3.
† Biol. Centralbl., xi. (1891) pp. 23–6.
‡ Zeitschr. f. Wiss. Zool., l. (1890) pp. 317–407 (4 pls.).
§ Biol. Centralbl., x. (1891) pp. 721–31.

gives a summary of all these researches, and in the present paper Ballowitz extends his observations to Coleoptera.

In beetles there are two main types of spermatozoa, connected, however, by intermediate forms. There is a double-tailed type already described by Bütschli and v. la Valette St. George, and there are others which are single-tailed. Bütschli showed that in the double spermatozoon, one tail filament is straight and stiff, the other is undulating and contractile. Ballowitz describes this type in *Hylobius*, *Chrysomela*, *Calathrus*, &c., and shows that the straight or supporting portion of the tail is elastic, but somewhat stiff, resistant to reagents and without any fibrillar structure, while the contractile fringe consists of an extremely complicated system of fibrils. The single-tailed type of spermatozoon, as seen e. g. in *Melolontha* and *Hydrophilus*, has no supporting fibres. The tail is twisted in a spiral, corresponds to the contractile fringe of the double type, and exhibits a complicated fibrillar structure. There is no need to attempt explaining how these spermatozoa, carefully macerated, &c., divide into peripheral, median, and fringing fibres, and these again into fibrils, for the details are unintelligible without the figures. The main point is the further demonstration of fibrillation in eminently contractile structure. Very interesting are Ballowitz's descriptions of the movements of the spermatozoa, e.g. how the fringed type works its way like the screw of a steamer. Raising the temperature of the medium from 20°–30° C. quickens movement; the optimum is from 30°–35° C.; above this towards 40° C. the power of movement is lost. Strong movements, especially in warmth, tend to produce a fibrous disruption of the spermatozoon. It is even observed that one of the contractile fibres of a complex spermatozoon may move independently of the others.

Parthenogenesis of Ants induced by heightened temperature.*—Herr E. Wasmann was able during three successive winters to induce parthenogenesis in the workers of *Formica sanguinea* and their helpers *F. fusca*, by artificially warming the nests. On one day as many as twelve workers of *F. sanguinea* were seen laying eggs. Most of them were large workers, but small forms were also affected, and the smaller the ant the more tedious was the egg-laying. Sometimes, however, they got obstetric assistance from others. Of the many hundreds of eggs thus laid none attained full development; as eggs or as larvæ all were devoured by the ants. It remains to corroborate these important physiological experiments by histological examination of the ovaries to see how their development is affected.

Can Ants hear?†—Herr E. Wasmann relates an interesting fact which he observed in studying a small colony of *Formica rufa*. The upper glass plate of a formicarium like that of Lubbock's had been cracked and mended with sealing-wax. When the dry sealing-wax was scratched with a needle, the ants suddenly raised their antennæ, moved rapidly, and sought to inspect the glass plate. They did so often, but paid little heed if the wax was rubbed with some smooth object which did not produce the small shrill sound caused by the needle. As Forel does not believe that ants hear, and as Lubbock's opinion that they do is based

* Biol. Centralbl., xi. (1891) pp. 21–3. † T. c., pp. 26–7.

on the anatomical discovery of probable sound-producing and sound-perceiving structures, Wasmann is naturally very cautious as to the conclusiveness of his own observation.

Development of Chironomus.*—Herr R. Ritter has reinvestigated the development of the reproductive organs, and has shown by means of sections that they arise from previously extruded "pole-cells" as Metschnikoff suggested, and as Balbiani carefully described. But as Balbiani did not make sections of the embryos, Ritter's corroboration is of much value, for he has followed the "pole-cells" from their appearance at the posterior pole of the ovum before the blastoderm is formed, through their stages of division and subsequent insinking, to their establishment as reproductive organs. By his sections Ritter has also confirmed what Weismann described in regard to the invagination of the hind-gut, while he agrees with Graber in referring the wall of the mid-gut to two lateral strands which arise from the union of segmentally disposed endoderm. His results are antagonistic to Völtzkow's, according to which the wall of the mid-gut arose by proliferation from fore and hind-gut.

After patient watching, Ritter was able to observe the nocturnal egg-laying. The insects after much hesitation lighted on the sides of the aquarium a little above the level of the water. A chain of eggs connected by gelatinous material is extruded on to the water; the jelly swells, and the chain floats. When the process is finished (in about five minutes), the insect moors the floating eggs by glueing the proximal end of the chain, and flies away. The author gives some interesting illustrations of the insect's marked preference for localities where the eggs are least likely to be frozen.

Histology of the Gut in the Larva of Ptychoptera contaminata.†—Prof. A. van Gehuchten has studied the histology of the gut in this Dipterous larva. In the œsophageal valve there is a remarkable vascular cavity between the proventricular epithelium and the muscular tunic. It is traversed by a muscular and elastic network with blood in the meshes. The lamellæ and fibrils of the network consist solely of plasmic reticulum without any enchylema. In this fact the author finds support for his theory of the structure of muscle, which he discusses at some length. The protective marginal portion (or "plateau") of the secreting cells is described very carefully; it is produced by a differentiation of the plasmic framework, and exhibits much complexity and variety. Like the nucleus it is passive during secretion.

Mechanism of Secretion in Larva of Ptychoptera contaminata.‡—Prof. A. van Gehuchten finds that the glandular epithelial cells of the mesenteron of the larva of this dipterous insect are well adapted for the study of the mechanism of secretion. The cells are provided with a protective cuticle which prevents external lesions. The products to be eliminated are formed in the body of the cell in consequence of the special activity of the cell; the elaborated products raise the covering

* Zeitschr. f. Wiss. Zool., l. (1890) pp. 408–27 (1 pl.).
† La Cellule, vi. (1890) pp. 185–289 (6 pls.).
‡ Anat. Anzeiger, vi. (1891) pp. 12–25 (7 figs.).

membrane and project into the intestinal cavity. These projecting vesicles then become free, either by constriction at their base or by the formation of a new membrane at the edge of the cytoplasm. This fall of vesicles gorged with the products of secretion into the intestinal cavity constitutes the excretion. The cell may then return to a condition of repose or commence a new secretion. An epithelial cell can go through the work of secretion and excretion several times without destruction. The cell is destroyed on the loss of its nucleus. Destroyed cells are replaced by fresh cells which are always to be found at the base of the secreting cell. The nucleus does not take any active part in the phenomenon.

Odoriferous Glands of Earwigs.*—Dr. J. Vosseler describes in *Forficula* and *Chelidura* the odoriferous glands which lie under the two pairs of lateral folds on the second and third abdominal segments. Each consists of a retort-like vesicle, containing a yellowish or brownish emulsion which can be ejected by a muscular action to a distance of 5–10 cm. and is well known to have an odour like carbolic acid and creosote. The emulsion is secreted by large cells which resemble, as Leydig suggested, the nematocysts of Cœlenterates. The secretion occupies the greater part of the cell, the nucleus is displaced to the side, a long chitinous tubule corresponds to the cnidocil. When the emulsion is ejected, the entire vesicle is compressed by external musculature, and the external aperture is opened by the *contraction* of a special muscle which is normally relaxed. The secretion is doubtless offensive, but it probably serves also as a useful varnish.

Stridulating Organ of Cystocœlia immaculata.†—Mr. R. T. Lewis gives a description of the sound-producing apparatus of this grasshopper. On each side of the third segment of the abdomen there is a yellow line about 5 mm. long which consists of a curved tube closed by a delicate operculum; arching over this tube is a graduated series of eight semicircular teeth. The counterpart is to be found on the inner surface of the femur of the hind leg, where there is a bow of fine teeth.

β. Myriopoda.

Hungarian Myriopoda.‡—Dr. E. Daday de Deés has written a monograph on the Myriopoda of Hungary. After a general account of the study of Myriopods, their structure, life, distribution, and classification, he proceeds to the diagnosis of genera and species classified as Diplopoda, Pauropoda, Chilopoda, and Symphyla. Three new species of *Julus*, four of *Polydesmus*, three of *Brachydesmus*, four of *Lithobius* are described among the rest.

Marine Myriopoda and Resistance of Air-breathing Arthropods to Immersion.§—Prof. F. Plateau calls attention to the two marine Myriopods found on the shores of Europe which are submerged at each

* Arch. f. Mikr. Anat., xxxvi. (1890) pp. 565–78 (1 pl.).

† Journ. Quek. Micr. Club, iv. (1891) pp. 243–5 (1 pl.).

‡ 'Myriopoda Regni Hungariæ' (in Hungarian), Budapest, 1889, 128 pp. and 3 pls.

§ Arch. Sci. Phys. et Nat., xxv. (1891) pp. 132–4.

tide; these are *Geophilus* (*Scotioplanes*) *maritimus* and *G.* (*Schendyla*) *submarinus*. There is nothing extraordinary in this resistance, for essentially terrestrial *Geophili* can exist in sea-water from twelve to seventy hours, and in fresh water from six to ten days. Forty-six genera and nearly eighty species of Arthropods are known to frequent the shores and to allow themselves to be submerged, though they breathe air. This resistance is not due to any special structure but to the general property of abranchiate Arthropods of being able to resist asphyxia for a long time. Swimming insects, such as the Dysticina which take with them a layer of air, resist submersion for a shorter time than insects which are exclusively terrestrial; this appears to be due to the greater activity of swimming insects in water and to the consequent using up of the oxygen possessed by them.

δ. Arachnida.

New Genus of Leaping Acari.*—M. Topsent and Dr. Trouessart describe a new form of leaping Acari which they call *Nanorchestes amphibius;* it was found on the shore at Calvados. The animal leaps so actively that the only way to catch it is to have pincers dipped in oil or glycerin. At first sight, nothing in the structure of the animal indicates the extreme agility of which it is possessed. The very sharp distinction between the abdomen and the cephalothorax, the presence of a single hook at the extremities of the legs, and other characters distinguish this form from any of the Eupodinæ, in which sub-family it may be placed. The form of the legs does not offer any explanation of the mechanism of leaping, for the hinder legs are no different from the others. It is probable that the animal folds its four pairs of legs under it and springs by suddenly separating them; the form of the tarsus would support this explanation.

Pycnogonidea of Norwegian North Sea Expedition.†—Prof. G. O. Sars gives detailed descriptions and drawings of all the species collected by the Norwegian North Sea Expedition, the material for which was very copious. This, with other specimens at his disposal, has enabled the author to acquire a good general view of the Pycnogonidian fauna of the Northern and Arctic Seas. The large number of species of Nymphonidæ is found to be eminently characteristic of the Northern Seas as contrasted with the Mediterranean, and the northern forms are also as a rule much larger; some are even gigantic.

Owing to the present unsatisfactory condition of the terminology employed for the various parts of a Pycnogonid, the author has a number of changes to propose, which are explained by a diagrammatic figure. Great care has obviously been taken with the determination of the species, and those now given as new, of which there are eleven, have already been noticed in brief preliminary descriptions.

The general systematic classification of the group is in an unsatisfactory condition, for now that it is recognized that the Pycnogonidea are neither Crustacea nor Arachnids, it is necessary to try and group the

* Comptes Rendus, cxi. (1890) pp. 891-2.

† 'Den Norske Nordhavs-Expedition 1876-78. XX. Pycnogoniden,' by G. O. Sars. Christiania, 1891, 163 pp., 15 pls. and 1 map.

families in larger divisions; Prof. Sars recognizes eight or nine families. In regarding the interrelations of these he has made use of the chelifori. In one group they are entirely wanting, except in the larva; in a second group they are always well developed, and in the third they are present in young post-larval stages, but afterwards disappear more or less completely. The following classification is proposed:—

Order I. Achelata.

Fam. 1. Pycnogonidæ. Gen. 1. *Pycnogonum.*
„ 2. Phoxichilidæ. Gen. 2. *Phoxichilus.*

Order II. Euchelata.

„ 1. Phoxichilidiidæ. Gen. 1. *Phoxichilidium.* Gen. 2. *Anoplodactylus.*
„ 2. Pallenidæ. Gen. 3. *Pallene*, Gen. 4. *Pseudopallene*, Gen. 5. *Cordylochele.*
„ 3. Nymphonidæ. Gen. 6. *Nymphon*, Gen. 7. *Chætonymphon*, Gen. 8. *Boreonymphon.*

Order III. Cryptochelata.

Fam. 1. Ammotheidæ. Gen. 1. *Ammothea.*
„ 2. Eurycydidæ. Gen. 2. *Eurycyde*, Gen. 3. *Ascorhynchus.*
„ 3. Pasithoidæ. Gen. 4. *Colossendeis.*

ε. Crustacea.

Eyes in Blind Crayfishes.*—Mr. G. H. Parker has examined the eyes of *Cambarus setosus*, a blind crayfish from caves in Missouri, and has compared them with those of *C. pellucidus* from the Mammoth Cave. He finds that both species still have the optic ganglion and nerve; the latter ends in the hypodermis of the retinal region, but the mode of its termination has not yet been discovered. In *C. setosus* the retinal region is represented only by undifferentiated hypodermis, composed of somewhat crowded cells, but in *C. pellucidus* there is a lenticular thickening, in which there are multinuclear granulated bodies; these appear to be degenerated clusters of cone-cells. The author confirms the results of Leydig, so far as they go, but is led to doubt the accuracy of Packard's observations.

Cirolanidæ and other Isopods.†—Herr H. T. Hansen gives an account of the Cirolanidæ, Corallanidæ, and Alcironidæ, and refers briefly to the Barybrotidæ, Ægidæ, and Cymothoidæ. He has studied thirty-four species, of which twenty-four are new. Perhaps the most important part of his memoir is the description of the mouth organs, their forms and movements, and their adaptation to various modes of life, e. g. in connection with incubation in many females. It is on the nature of these organs that he bases his classification, with this advantage among others that the great distinctions can be readily recognized with

* Bull. Mus. Comp. Zool., xx. (1890) pp. 153-62.
† Skrift. K. Danske Vid. Selsk., v. (1890) pp. 239–426 (10 pls.).

the lens. We can give an illustration only of how the classification is worked out:—

Palp of the maxillipedes is free; the margins of the last two joints are more or less setose, never with hooks. The lacinia of the third joint of the first maxilla at least towards the middle is rather broad.	Palp of the maxillipedes surrounds a cone formed from the distal portions of the other mouth-parts; the intero-superior margin and apex are never setose, the apex and sometimes the intero-superior margin at least in the males and young females bear curved hooks. The lacinia of the third joint of the first maxilla is always narrow.
Cirolanidæ, Corallanidæ, Alcironidæ.	Barybrotidæ, Ægidæ, Cymothoidæ.

Oviposition and Fertilization in Asellus aquaticus.*—Herr G. Leichmann finds that Rosenstadt is not right in thinking that the oviposition of the Asellina is exactly similar to that of the Oniscidæ, as described by Schöbl and Friedrich. The ecdysis which takes place immediately after fertilization does not cause the disappearance of the genital orifices: they are merely hidden by the now developed brood-lamellæ. The brood-plates appear very early as short delicate processes at the base of the first four pairs of legs. They do not arise as mere thickenings but are evaginations of the hypodermis, and consequently inclose a cavity which is in free communication with the body-cavity; in the interior of the larger processes the hypodermis becomes converted by numerous foldings into brood-lamellæ. Fertilization is not effected, as Sars supposed, in the brood-space, but in the ovary; before it is effected the middle part of the oviduct swells out into a large receptaculum seminis, into which the sperm-mass is received. After oviposition the oviducts shrink down again to their original form.

Care of Young in Isopoda.†—Herr G. Leichmann makes a contribution to our knowledge of this subject by an account of his observations on *Sphæroma rugicauda;* the transparent embryos are not inclosed in the brood-cavity but in saccules with delicate membranes which lie in the interior of the body of the mother.

Dimorphism of male Amphipoda.‡—M. J. Bonnier records some observations on this subject. Some years since Fritz Müller described the dimorphic males of *Orchestia Darwini*, and other cases have since been described; these have been explained by Faxon, who points out that there is no true dimorphism, but rather a succession of forms, one of which is and the other of which is not adapted for copulation.

M. Bonnier has been able to confirm the truth of this explanation by a study of *Orchestia littorea* and *Bathyporeia pilosa*. The presence of matured testes in the non-copulatory form of the former is not a sufficient argument against this explanation, for other Crustacea are known in

* Zool. Anzeig., xiii. (1890) pp. 715-6.
† T. c., pp. 688-91.
‡ Comptes Rendus, cxi. (1890) pp. 987-9.

which one or more ecdyses are required after the maturation of the testes before copulation is possible; here one ecdysis is all that is needed. *Bathyporeia pelagica* is the female, and the form described as *B. Robertsoni* is the copulatory male of *B. pilosa*. It follows that the so called dimorphism of male *Amphipoda* is really a case of progenesis as in some other Crustaceans.

Maturation of the Ova of Cyclops.*—Dr. V. Hæcker has studied the ova of various species of *Cyclops*, in order to determine the precise moment at which a reduction of chromatin elements takes place. Differing from Boveri, who refers the reduction to a period in the history of the germinal vesicle antecedent to the expulsion of the polar bodies, Hæcker finds by careful observation that the reduction takes place in the expulsion of the first.

Movements in the Brain of Leptodora.†—Prof. R. Wiedersheim describes a remarkable region in the brain of *Leptodora hyalina*, in which granules and cells and vacuoles appear to be very mobile, changing their form or position while examined. The mobile zone is that with which the main nerves are connected, and must therefore be of great morphological and physiological importance. Instead of being rigid the central nervous substance has the power of active movement, but what this precisely means has yet to be discovered.

Hermaphroditism of Apodidæ.‡—The Rev. H. Bernard has investigated the structure of *Apus cancriformis*, the reproduction of which has been the cause of so much speculation. As is well known, this species is remarkable for the rarity of its males, and Mr. Bernard now shows that it is really hermaphrodite. The discovery commenced with a study of *Lepidurus glacialis*, which was found to be hermaphrodite. *A. cancriformis* and *L. productus* were then investigated, and in both it was found that the sperm-forming centres are scattered here and there among the rich branchings of the segmental diverticula of the genital tube. They occur either at the tips of such branches, where the eggs ordinarily develope, or as slight lateral bulgings of the same. Further details and drawings are promised.

The origin of this secondary hermaphroditism is to be found in the manner of life of these animals, which are always in danger of being cut off from their kind. The males of the Apodidæ seem to be generally smaller than the hermaphrodites, and this is the only point of sexual dimorphism which they exhibit; on the other hand it will be remembered that in the Cirripedia this sexual dimorphism is much more marked.

Development of Ascidicolous Copepoda.§—M. E. Canu remarks that circumstances have led to a remarkable condensation of the embryogeny of these Crustacea. In the Notodelphyidæ the first *Nauplius* has, in addition to the three pairs of characteristic appendages, the indications of two pairs of maxillæ and two pairs of thoracic legs. The endoderm forms a compact cellular mass; on its dorsal surface there are

* Zool. Anzeig., xiii (1890) pp. 551-8 (1 fig.).

† Anat. Anzeig., v. (1890) pp. 673-9 (5 figs.).

‡ Nature, xliii. (1891) pp. 343-4. Jenaische Zeitschr. f. Naturwiss., xxv. (1891) pp. 337-8.

§ Comptes Rendus, cxi. (1890) pp. 919-20.

attached the double muscles which move the naupliar appendages. The embryo undergoes several ecdyses before ceasing to have the form of the typical *Nauplius*. It becomes converted into the *Metanauplius* by the appearance of a rigid seta at the tip of the tegumentary fold which forms the first maxilla. The tripartite eye of the adult and the third thoracic somite, with its pair of appendicular thickenings, now appear. The next stage is the first cyclopoid stage, in which the body consists of six segments and a furca. In the second cyclopoid stage there are seven segments; the embryos swim actively towards light, and their musculature is well developed. In the next stage the young Copepods enter the Tunicate which shelters them. In the Enterocolidæ the metamorphoses are now abbreviated, and the author has not seen the *Metanauplius*-stage.

Dendrogaster, a new form of Ascothoracida.*—Herr N. Knipowitsch describes *Dendrogaster astericola* g. et sp. n., a remarkable Crustacean parasite, previously found by Prof. N. Wagner in *Echinaster sarsii* and by Prof. W. Schimkewitsch in *Solaster papposus*. Knipowitsch discovered it again in the body-cavity of *Echinaster sarsii*, and found it filled with *Cypris*-like-larvæ, which lived for some time in the aquarium. The parasite is about 9 mm. in length, 10–11 mm. in breadth; the colour is orange-red; the shape is that of a double-lobed sac, the right and left halves of which are connected by a bridge, raised like a cone and bearing a dorsal aperture. The organs of the body lie for the most part in this conical region, the rest is a mantle with branched prolongations from the stomach. On the ventral surface lie a pair of four-jointed antennæ with strong hooks, a large oral cone with a strong lip, a pair of maxillæ, and some doubtful rudiments. A roundish region, which bears the opening of the vas deferens on a terminal papilla, corresponds to the abdomen. The gullet is lined by chitin, the stomach is much branched, there is no hind-gut nor anus. Round the gullet lies the nervous system, with supraœsophageal ganglion, subœsophageal ganglion, commissures connecting them, and a reduced rounded ventral chain. Paired testes lie ventrally in the abdomen; the lobed ovary lies in front of and above them. The larvæ were certainly *Cypris*-like, but Knipowitsch found that they differed in several respects from those of Cirripedes. As to the position of this strange animal, he ranks it with *Laura gerardiæ* (Lacaze Duthiers), *Synagoga mira* (Norman), *Petrarca bathyacthidis* (Fowler), in the group Ascothoracida, as a subdivision of Cirripedia. The geographical distribution of the group is remarkable, for *Laura* occurs in the Mediterranean towards the African coast, *Synagoga* in the Gulf of Naples, *Petrarca* at a depth of 2300 fathoms (lat. 35° 41′ N., long. 157° 42′ E.), and *Dendrogaster* in the White Sea at a depth of a few fathoms.

Monstrilla and the Cymbasomatidæ.†—Mr. I. C. Thompson urges reasons against the view of Mr. G. C. Bourne, that the Cymbasomatidæ should be regarded as a subfamily of the Corycæidæ, and he places their distinctive characters in a clear way before us. He urges that they should be kept distinct, and suggests that the natural position of the family is close to the Artotrogidæ.

* Biol. Centralbl., x. (1891) pp. 707-11 (3 figs.).
† Trans. Biol. Soc. Liverpool., iv. (1890) pp. 115-24 (1 pl.).

Vermes.

a. Annelida.

Origin of Mesoblast-Bands in Annelids.*—Mr. E. B. Wilson has long been seeking to reconcile the observations of those who, following Salensky, have described the mesoblast-bands of Annelids as arising in some cases by direct proliferation from the ventral ectoblast, with those of such as Kowalevsky, who have demonstrated that in some cases the mesoblast first appears in the form of large cells (teloblasts), by the proliferations of which the paired mesoblastic bands arise. He hopes that the study of the early stages of *Nereis limbata* and *N. megalops* will help to clear the way. The eggs of these worms are extraordinarily favourable for investigation, as they are transparent, of comparatively large size, and can be procured in abundance. As in *Lopadorhynchus* and other types, the trochophore seems to consist at first of two layers only. The mesoblast, like the neural foundations and those of the seta-sacs, arises directly from a thickened bilobed ventral plate; that is, it seems to arise from the ectoblast. But closer examination shows that the cells of this ventral plate differ from the remaining cells of the outer layer; they are larger, differently granulated, and, with certain reagents, assume a brownish colour that marks them off very sharply. It is possible, therefore, to trace their origin, and it may be found that the mesoblast is completely segregated in the anterior part of the plate, while the posterior part alone gives rise to ectoblastic structures. Each of the two divisions of the ventral plate may be traced back to a single cell (pro-teloblast) which is obviously homologous to a corresponding cell in the early embryo of *Clepsine*. These two cells the author calls X and Y, and he tells us that from the latter arise the mesoblast-bands, and from the former the neural plates, the seta-sacs and other structures still undetermined. After tracing the fate of each of these cells through several stages, Mr. Wilson proceeds to compare the history with that of *Clepsine* and *Lopadorhynchus*. In *Clepsine* the large posterior macromere first separates off a single micromere (as in *Nereis*), and then divides into two large cells. The upper right-hand cell (neuro-nephroblast of Whitman) has precisely the same relation to the rest of the embryo as the first pro-teloblast of *Nereis*. In *Clepsine* this cell breaks up into eight teloblasts, but in *Nereis* into four only; the succeeding history of each shows, however, that it is practically certain that the first pro-teloblast of *Nereis* is the homologue of the "neuro-nephroblast" of *Clepsine*, while the second pro-teloblast of *Nereis* is the homologue of the common primary mesoblast of *Clepsine*. These two forms agree in all essential points; and they differ only in secondary details—in the ultimate number and arrangement of the teloblasts, and in the temporary position of the products.

Mr. Wilson thinks that the bilobed ventral plate of *Lopadorhynchus* must be regarded as the homologue of the ventral plate of *Nereis*. They differ only in the earlier segregation and differentiation of the mesoblastic material in *Nereis*, which leads to the formation of a pair of transitory telobasts, which, however, form part of the ventral plate.

The author then raises the question whether the secondary mesoblasts

* Journal of Morphology, iv. (1890) pp. 205-19 (6 figs.).

of Annelids can be shown in all cases to arise from a single pair of teloblasts; at any rate, the case of *Nereis* shows that such may be present only in very early stages, and so be easily overlooked. In *Polygordius* it seems to be certain that no teloblasts of any kind are present, even in the youngest stages. On the other hand, the case of *Nereis* shows that it is not safe to assume the absence of teloblasts without following the development, cell by cell, from the very beginning, and that, whenever it is possible to make such a detailed study, we may pretty confidently expect to find teloblasts. In Mr. Wilson's opinion it is not rash to predict that the secondary mesoblast bands even of *Lopadorhynchus* will yet be shown to arise by teloblastic development.

In a footnote the author informs us that, by a study of *Hydroides dianthus*, he has been able to discover that the head-kidney opens posteriorly into the proctodæum. Under a high power the canal can easily be followed from its beginning near the front end of the organ and along its outer dorsal border into the anterolateral part of the proctodæum. This fact serves to remove all doubt as to the homology of the head-kidney of the trochophore with the nephridia of the Rotifera.

Development of the Earthworm.*—Prof. R. S. Bergh gives a critical account of the different conclusions which have been maintained in regard to the differentiation of the germinal layers in *Lumbricus* and other Annelids, and relates his own observations. From the most median of the four rows of cells described by Wilson the nerve-chain is formed, but in its development an epidermic nervous plexus of yet earlier origin takes part. The three lateral rows of cells form the circular musculature, while the longitudinal muscles arise from internal muscle-plates. As to the nephridia, funnel and coil and terminal portion differentiate from a common rudiment which arises in the internal muscle-plates without any help from the epidermis. Nor do the successive nephridia have any connection with one another. Bergh is as strongly opposed as ever to the theory that Annelid nephridia are homologous with the excretory tubules of Platyhelminthes and Rotifers. The last part of Bergh's memoir, which is characteristically critical, is devoted to maintaining that the entire germinal streak of Annelids is a unity fundamentally ectodermic.

Cutaneous and Muscular Systems of Earthworm.†—Dr. P. Cerfontaine has an elaborate paper on the cutaneous and muscular systems of *Lumbricus agricola*. The body-wall is discussed under the heads of (1) cuticle, (2) hypodermis, (3) muscular layers, (4) peritoneal membrane, and in the discussion of the second of these the hypodermis strictly so called is considered separately from the clitellum and parts connected therewith.

It is very probable that the cuticle is merely the result of the transformation of the superficial protoplasm of the hypodermic cells; it is very regular in structure, and it may be supposed that the bundles of the cuticle result from a sort of keratinization of the interfibrillar substance of the protoplasm; the striæ would then be the result of the more or less complete disappearance of the protoplasmic network; this is the more probable, as swellings are often found at the intercrossings

* Zeitschr. f. Wiss. Zool., l. (1890) pp. 469 526 (3 pls.).
† Arch. de Biol., x. (1890) pp. 327–428 (4 pls.).

of the striæ, which are altogether similar to those which are to be seen at the intersections of the filaments of the network. The cuticle can be regenerated when it has been accidentally removed from any part of the body.

The hypodermis is a true cylindrical epithelium formed of three sets of cells—superficial, intermediate, and basal; they inclose a number of unicellular glands, which are of two kinds, varying with the character of the secretion which they pour out on to the surface of the body by means of the small canals which perforate the cuticle. The substance secreted by the glands has certainly the function of stopping evaporation and maintaining humidity, while the mucus serves as a kind of cement for the walls of the galleries which these worms excavate.

The clitellum is a complicated organ, and in the ventral part, which should be distinguished from the dorsal, the genital groove and the pads of the groove should be noted; each of these last is divisible into an anterior and a posterior portion. A great deal of observation might profitably be devoted to this organ, the function of which is almost unknown. It is very probable that the pads of the groove become more prominent at the time of copulation, in consequence of the contraction of the arciform muscles; the genital groove would then become deeper; and as in copulation worms lie with the pads applied to one another, the grooves of the pair would form a canal through which the sperm might run.

The muscular system is divisible into the muscular layer of the wall of the body, that of the wall of the digestive tract, the muscles of the intersegmental septa, and the muscular envelope of the central nervous system. But all these parts are connected among themselves. In the first set we find, in addition to the circular and longitudinal muscles, the arciform muscles which lie only between the sexual orifices and the hinder end of the clitellum, and the muscles of the setæ. The characters of the muscular element of the earthworm, which are always the same, can be best studied in a piece of the gizzard. It exhibits a longitudinal striation, and at certain points one can distinguish a trans verse striation; the striæ are not simple lines, but are moniliform, being due to a number of swellings connected with one another by more delicate parts. The author deals in a very detailed manner with the muscular system.

The peritoneal membrane, seen from the surface, has the appearance of a pavement epithelium; the cells which form it are polygonal; in section they are flattened; those near the longitudinal muscles have their protoplasm fusing insensibly with the intercolumnar granulated substance. Nuclei of various sizes are seen, and some nuclei had several smaller nucleoli in addition to the large one.

The appearances seen justify the belief that direct nuclear division was going on in these cells; there were no certain indications of pathological degeneration or of processes of fusion. In more than twenty cases which were examined essentially similar phenomena were observed. Further investigations, however, are necessary, and fresh specimens will have to be studied.

Megascolex cæruleus.*—Prof. A. G. Bourne gives an account of this earthworm from Ceylon, and proposes a theory of the course of the

* Quart. Journ. Micr. Sci., xxxii. (1891) pp. 47-87 (4 pls.).

blood in earthworms. He does not give any account of its general appearance but gives a figure which appears to be excellent. After some considerable additions to the details of our knowledge of various organs, the author proceeds to propound his new theory of the circulation.

According to this, so long as the modified anterior extremity (of about the first twenty segments) remains intact, it is possible to remove any of the posterior segments without interfering at all with the circulation, in other words, there are signs of a metamerically segmented character of the vascular system, in all but the "cephalized" anterior region. The blood appears to enter the dorsal vessel in each posterior segment through dorso-intestinal, and to leave it by dorso-tegumentary vessels; the latter are always small as compared with the former (of which, indeed, there are in many worms two pairs in a number of segments), and it is probable, therefore, that more blood enters the dorsal vessel than leaves it in each posterior segment. This excess is passed forward to be sent out in the cephalized region. With regard to the supply in the ventral vessel, all the blood which enters it comes from the hearts, and all the ventro-tegumentary branches appear to be efferent vessels. Contrary to the ordinarily received opinion that all the blood in the ventral vessel flows backwards, Prof. Bourne is of opinion that in front of the heart the direction of flow is forwards.

As to the capillary networks, it seems that the afferent vessels of the peripheral networks are in all cases branches of the dorsal and ventral vessels, while their efferent vessels are branches of intestino-tegumentary vessels, and the afferent branches of the intestinal networks are branches of the intestino-tegumentary trunks; the efferent vessels of this last system are branches of either the typhlosolar, the supra-intestinal, or the dorsal vessel, so that blood coming from them is driven either into the hearts or into the dorsal vessel at its anterior extremity, in either case into peripheral networks; from these the blood passes into the intestino-tegumentary system, and once more into the intestinal capillaries. Prof. Bourne points out that a merit of this theory is that it exhibits the vascular system as a perfectly metamerically segmented organ, the portion of it which is contained in the cephalized region representing, as a whole, almost exactly the portion contained in any other segment of the body; it has undergone a synthesis, and certain additional structures, the hearts, have become developed in its region.

New Genus of Earthworms.*—Dr. R. Horst has a preliminary note on a new earthworm brought by Prof. Max Weber from the Malay Archipelago. The genus is to be called *Glyphidrilus* (*G. Weberi*) on account of the clitellum being provided on each side with a folded, crenulated ridge. One to three pairs of spermathecæ are to be found in each segment from xiv. to xix., and all were densely filled with spermatozoa. The new genus is specially characterized by the backward position of the male genital pores, the situation of the spermathecæ behind the other genital organs, and by the presence of more than one pair of them in each segment. The male pores are between segments xxvi. and xxvii., and their position in the intersegmental groove is also of rare occurrence.

* Zool. Anzeig., xiv. (1890) pp. 11–12.

Structure of the Oligochæta.*—Mr. F. E. Beddard, referring to Dr. W. B. Benham's division of the Lumbricomorpha into Microdrili and Megadrili, points out that the presence or absence of a capillary network upon the nephridia is not the only character by which these two orders might be distinguished. There are in addition—

Microdrili.	Megadrili.
(1) Sexual maturity at a fixed period.	(1) Sexual maturity more or less continuous.
(2) Clitellum consisting of a single layer of modified cells only.	(2) Clitellum consisting of two distinct layers of cells.
(3) Ova large and few.	(3) Ova small and numerous.

Ocnerodrilus, however, presents such an admixture of these characters that the proposed division seems almost impossible. Mr. Beddard is inclined for the present to revert to Vejdovsky's arrangement into families only, and he points out that, in discussing the affinities of any particular type of Oligochæta, it is necessary to compare it with a particular family.

Pelodrilus is the name proposed for a new generic type of Annelid collected, in New Zealand, from wet soil near the margin of a swamp. Among other points of interest this new worm has specially thickened intersegmental septa in some of the anterior segments; this tends to show that the medium in which the worm lives has some relation to the presence of these thick septa; for it does not, like its immediate allies, swim in water or burrow in naturally soft mud.

Phreodrilus is another new New Zealand worm in which the general arrangement of the sperm-duct is quite unique, unless it resembles that of *Eclipidrilus*. The atrium commences as a sinuous tube which widens out to form a large thin-walled sac with muscular walls; this sac is nearly filled by a much coiled continuation of the atrium and vas deferens. This genus has highly characteristic setæ; the dorsal rows consist each of a single capilliform seta, not unlike those of the Tubificidæ; the ventral setæ are not quite similar to those of any known Oligochæte. Mr. Beddard concludes with a note on the zone of growth in *Urochæta*, and a brief description of a new species of *Pontodrilus* from Bermuda, in which the gizzard is very feebly developed.

Homology between Genital Ducts and Nephridia in Oligochæta.†—Mr. F. E. Beddard has studied the development of *Acanthodrilus multiporus*. In the young embryos each segment is furnished with a pair of nephridia, each opening by a ciliated funnel internally. Later on, the funnels degenerate and that portion of the tube which immediately surrounds the funnel becomes solid. At the same time the nephridium branches and communicates with the exterior by numerous pores. At a rather early stage four pairs of gonads are developed in segments x.–xiii., each on the posterior wall of its segment; the funnels in close contact with them increase greatly in size and become the funnels of the vasa deferentia and oviducts; subsequently the gonads and commencing oviducts of segment xii. atrophy.

The author can only explain these and other facts which he brings

* Ann. and Mag. Nat. Hist., vii. (1891) pp. 88–96 (2 figs.).
† Proc. Roy. Soc., xlviii. (1891) pp. 452–5.

forward by the supposition that in *Acanthodrilus multiporus* the genital funnels and a portion at least of the ducts are formed out of nephridia. This mode of development confirms the suggestion of the late Prof. Balfour that in the Oligochæta the nephridium is broken up into a genital and an excretory portion.

Reproduction of Autolyteæ.*—M. A. Malaquin has studied the formation of the stolons in *Autolytus*, *Myrianida*, and *Procerastea*. Some species of *Autolytus* exhibit merely fission, while in others there is fission and budding. In *Myrianida* there is budding without fission. When there is budding the somite which proliferates is the pre-anal in *Myrianida* and certain species of *Autolytus;* the anal segment is, from the first, too differentiated to take part in the formation of new zoonites. The "formative zoonite" has no appendages; it is filled by embryonic tissue; when it exists it gives rise, when there is a free proximal surface, to a new head (centrifugal budding), or when the free surface is distal to a new pygidium (centripetal budding). If the formative zoonite is in contact with a stolon, a pygidium is formed on the dorsal surface; the anal segment plays, so to speak, the part of an isolator; it separates two individualities which are becoming more and more marked. The zone of new formation is colourless and transparent: the formative zoonite is larger than the zoonites which precede it. On this segment, which is at first undivided, there appear two lateral grooves which converge and meet on the median line; the rudiments of feet, cirri, setæ, are successively differentiated. In *Myrianida* the author observed a stem of sixty-six segments, followed by twenty-nine male stolons, containing about four hundred and fifty segments, and thirty actively proliferating zones.

Reproduction has also been observed in *Procerastea Halleziana* sp. n.; here the phenomenon of fission is complicated by a median budding before the appearance of the head. The proliferating bud only gives off segments anteriorly.

The growth of the stolons is described in *Polybostrichus* and *Sacconereis*. In the former the formative zoonite immediately gives rise to the two most differentiated segments—the segment which buds off the head and the pygidium; the segments next to be formed are those which contain the genital organs. The head of *Sacconereis* is formed in the same way as that of *Polybostrichus*. Dimorphism is much more marked in this genus.

β. Nemathelminthes.

Filariæ of Birds.†—Dr. T. L. Bancroft has investigated the hæmatentozoa of Australian birds, and, as he was fortunate enough to find them in the Blue-Mountain Parrot, which eats only honey, he was able to trace the cycle of changes. This parrot harbours, as most birds do, a blood-sucking louse. The author, therefore, believes himself justified in assuming that the lice of birds are the intermediate hosts in the life-history of the *Filariæ* of birds, and that birds infect themselves by picking lice from an infected bird, and afterwards re-infect themselves by picking their own lice; this would account for the immense number of hæmatentozoa

* Comptes Rendus, cxi. (1890) pp. 989-91.

† Proc. Roy. Soc. Queensland, vi. (1889) pp. 58-62.

in some birds. In examining birds for embryonic *Filariæ*, it is best to cut out the heart and press it gently against a slide so as to leave thereon a little blood, for the blood in the heart often contains worms when they are not to be found elsewhere in the body. The blood should be examined immediately after death; if a period of thirty hours has passed it is impossible to find them.

Atlantonema rigidum.*—M. R. Moniez has some observations on this Nematode, which is parasitic in various coprophagous Coleoptera. The worm loses most of its organs, and particularly its digestive tube, so that it has merely the character of a long sac filled with embryos of all degrees of development. These break through the wall of the maternal body and spread in large numbers among the viscera of their host. A certain degree of development is possible within the body; regarding the further stages of their history, the author can only as yet surmise as to their relation to the Rhabditis-like forms which are found on the backs of these Beetles.

Development of Gordius.†—Dr. L. Camerano finds that the principal phenomena of maturation and fertilization in the ova of *Gordius tolosanus*, *G. villoti*, &c., are like those of *Ascaris megalocephala*. The segmentation is total but irregular, and results in a two-layered "sterroblastula," which is transformed into a "cœlogastrula." He maintains that the resemblance between the development of *Gordius* and that of other Nematodes justifies the retention of the Gordiidæ as a distinct order within the class.

Histology of Echinorhynchus.‡—Herr J. Kaiser begins an account of the Acanthocephala, which, so far as yet published, deals mainly with their histology. Of the nine species which served as material for his researches, two are new, *E. uncinatus* and *E. spinosus*, both from Florida. The cuticle, the felt-like subcuticula, the radial fibrils of the hypodermis, the lemnisci are described at great length, and a summary is given of what is known in regard to the absorption of food. So far, almost all the results reached corroborate those of previous investigators.

γ. Platyhelminthes.

Rhabdocœle Turbellaria.§—Dr. L. Böhmig, in his second memoir, deals in a very detailed manner with the Plagiostomina and Cylindrostomina of Graffs. We have only space to notice a few of the many points discussed by the author. The reactions of the rhabdites and pseudorhabdites to colouring matters are so very various that we may conclude that their chemical composition varies considerably, and that, perhaps, their function does so also. The parenchyme of the Turbellaria primitively consists of individualized cells, and the manner in which they fuse varies considerably. In the Alloiocœla and in some of the Rhabdocœla there is in each cell a differentiation into supporting and sap-plasma, and the cell-walls of the cells fuse with one another. In the two divisions of the Dendrocœla and perhaps in some Rhabdocœls fusion

* Comptes Rendus, cxii. (1891) pp. 60–2.
† Mem. R. Accad. Sci. Torino, xl. (1890) pp. 1–18 (2 pls.).
‡ Bibliotheca Zoologica, Heft 7 (1891) pp. 1–40 (6 pls.).
§ Zeitschr. f. Wiss. Zool., xli. (1890) pp. 167–479 (11 pls., 21 figs).

of the cells is accompanied by the formation of vacuoles. Some of these at least are intercellular in Triclads, but they are always intracellular in Polyclads. The division of the parenchymal tissue into connective bars and connective cells must be given up.

These Turbellaria always have a large number of glands in their body, and most of them are dermal. Some open into the pharynx and these may be regarded as salivary glands. The pharynx itself is very elaborately constructed. The form of the enteron is greatly influenced by the degree of development of the generative organs, and there is no doubt that in young animals, where these parts only exist in rudiment, the form of the enteron is much more regular and straight. Respiration appears to be effected through the walls of the enteron and of the body as well as by means of the water-vascular system.

With regard to the structure of the nervous system the author agrees with Leydig and Nansen in regarding the substance which fills Haller's plexus as the hyaloplasm of Leydig and as the true nervous substance, but he differs from Nansen in so far that he believes that the fibres and fibrils of this nervous substance form a network and anastomose with one another.

In the eyes of all alloiocœlous Turbellaria we may distinguish a pigment layer or pigment cup, refractive media or lens-cells, and perceptive media or a retina. In the last the layer of rods must be distinguished from the optic nerve. There is much in common between the eyes of Alloiocœla, Triclads, and Polyclads, but the two last most resemble one another in the structure of the retina. The complete absence of lens-cells in Polyclads and Planarians is to be noted.

In treating of tactile organs Dr. Böhmig points out that at the base of the tentacle there are numerous ganglionic cells, the processes of which form a small accumulation of dotted substance, whence fibres pass into the tentacles. He does not know whether the central part of these tentacles is filled by nerve-fibres or whether parenchymatous tissue is also there present. In the epithelium of a comparatively well-extended tentacle peculiar bodies were found just beneath the cuticle; these possibly represent nerve-end-organs, but no connections with nerve-fibres were detected. These bodies are exceedingly small and have the form of lenses; in the middle of the more convex surface there is a small round spherule from the surface of which fine striæ radiate; these striæ appear to be continued into minute and fine hairs.

Some considerable space is devoted to the generative organs.

In the second portion of his paper Dr. Böhmig deals with the anatomical characters of *Plagiostoma Girardi*, both large and small varieties, the latter of which is new, *P. reticulatum*, *P. siphonophorum*, *P. maculatum*, *P. bimaculatum*, *P. dioicum*, *P. lemani*; *Vorticeros auriculatum* is next considered. Among the Cylindrostomina we find a new genus *Monoophorum* for *M. striatum* sp. n.; the genus is defined as belonging to the Cylindrostomina and as having a common oral and genital orifice which is situated near the hinder end of the body; the pharynx is directed backwards and the penis forwards; the bursa seminalis communicates with the genital atrium; the rudiments of the two yolk-glands are fused in the median plane on the dorsal side. In it as in *Cylindrostoma* the testes are situated more anteriorly than in Plagio-

stomina, and have, consequently, well-developed and long vasa deferentia, which are wanting in the other group. The species of *Cylindrostoma* described are *C. quadrioculatum* and *C. Klostermanni*.

Turbellaria of the Coasts of France.* — In the present memoir Dr. L. Joubin confines himself to an account of French Nemertinea; his chief object is to give an "aperçu" of the fauna and he notes as much as possible the habitat of the worms and the external details which are often so difficult to see. Thirteen species were found to be peculiar to the Atlantic, seventeen to the Mediterranean, and twenty-eight were common to the two areas. *Carinella banyulensis* sp. n. was first thought to be the young of *C. annulata*, but its maturity was proved by its being discovered reproducing itself; *C. aragoi* is a new species also from Banyuls. In describing *Polia curta* the author, which he rarely does, enters into some anatomical details. The new genus *Poliopsis* is suggested for *P. lacazei* sp. n., but the author does not distinguish between what he regards as the generic and what as the specific characters. The names *marionis* and *rustica* are applied to new species of *Tetrastemma*. The only new species of *Nemertes* is *N. duoni*.

Asexual Reproduction of Microstoma.†—Dr. F. von Wagner has made a study of the asexual reproduction of this worm. He is not able to confirm v. Graff's statement that the length of proliferating specimens is from 0·7 to 1·5 mm., as he has observed examples 2 mm. long in which there was no indication of the reproductive process. The law of Hallez that rudiments of new zooids always appear in the last third or fourth is not universally true. There are great variations in the rhythm of asexual propagation, and v. Graff's formula is rather a theoretical generalization from special cases than the result of comparative observation. Hallez's "temps de formation" does not so much fix a definite developmental stage of the developing zooid as represent a special stage of the mother; the isolated hinder piece is not a localized growth-product of the animal which is known as the mother, but is merely a part of it; the constancy in size of the most anterior animal of a chain, which v. Graff supposes to continue for the whole period of asexual propagation, does not really obtain. The internal processes which accompany asexual reproduction may be considered under two heads:—

A. *Formation of septa and separation.*—The enteric tract becomes constricted in the septal plane, and is, consequently, in a state of latent tension of high degree; the process of separation happens at a period characterized by the growth-energy of the epithelial circular groove having reached a stage in which it is superior to the tension of the constricted enteron.

B. *The processes of regeneration* are discussed in eight brief chapters they chiefly consist of changes in and differentiations of the formative cells belonging to the parenchyma. If what happens in *Microstoma* is compared with what is known to occur in other Turbellaria, we are led to the generalization that in the Turbellaria regenerations take their origin from the parenchyma (mesoderm); in other words, the regene-

* Arch. Zool. Expér. et Gén. viii. (1890) pp. 461–602 (7 pls.).
† Zool. Jahrb. (Abth. f. Anat. u. Ontog.), iv. (1890) pp. 349–423 (4 pls.).

rative activity of these animals appears to be connected with the formative capacity of the parenchyma.

The author proceeds to some general remarks on division and budding in the Animal Kingdom. He draws a sharp distinction between the two processes, and comes to the conclusion that asexual reproductions in different phyla of Animals have arisen independently of one another.

Helminthological Studies.*—Prof. M. Braun has a notice of some recent work on parasites done under his direction. Herr C. Dieckhoff has investigated the ectoparasitic Trematodes; he finds the vitello-intestinal canal in *Octobothrium merlangi*, *O. lanceolatum*, and *Axine belones*. The canal appears to be wanting in the Tristomeæ and in the Temnocephala.

Herr F. Matz has investigated the Bothriocephalidæ with the object of finding in the topographical relations of the generative apparatus better means for discriminating the species than we have had hitherto. A series of specific differences have, as was expected, been discovered; the generative orifices are ventral or marginal; differences, though not very considerable, have been seen in the number and size of the testicular vesicles, and there are some points in the vitelline follicles. The number of uterine loops may be greater or less than in *Bothriocephalus latus*.

The Genus Vallisia.†—Sigg. C. Parona and A. Perugia described as a new genus of Trematode, under the title *Vallisia striata*, an ectoparasite on the gills of *Lichia amia;* the body consisted of two parts in different planes, and was covered with fine transverse striæ; there were two minute ventral and eight caudal suckers. But Dr. P. Sonsino has denied the validity of this new genus, and described the same worm under the title *Octocotyle arenata* sp. n. Parona and Perugia vindicate the claims of their genus.

Morphology of Cestoda.‡—Dr. T. Pintner first discusses the vexed question of the act of fertilization in the Cestoda. He has been so fortunate as to have found in a *Mustela lævis* two free proglottids of an *Anthobothrium Musteli* which appeared to be in copulâ. These two joints, which seemed to be of much the same age, showed no signs of any separation-wound; the uterus was full of eggs, though not overcrowded by them. Both joints had their anterior ends pointing in the same direction, but the ventral face of one ring looked in the same way as the dorsal face of the other. It is very possible that their long axes slightly crossed one another. There was true cross-fertilization, for the penis of one individual was fixed in the vagina of the other; each reached only so far as the point where the vagina begins to narrow, but as this is not always the case, the author supposes that copulation was nearly finished when the preparation was fixed. The penis is able to extend itself into a retort-form, and to considerably alter its diameter.

This fortunate accident makes it certain that typical cross-fertilization of the kind that is seen in Snails obtains in the Cestoda; it would hardly seem to be a hasty generalization that this is the rule in all

* Centralbl. f. Bakteriol. u. Parasitenk., ix. (1890 [1]) pp. 52–6.
† Zool. Anzeig,, xiv. (1891) pp. 17–9.
‡ Arbeit. Zool. Inst. Wien, ix. (1890) pp. 57–84 (2 pls.).

cases where a number of sexually mature joints are retained in the host, whether in the chain-form or in free proglottids.

Soon after the discovery of these joints Dr. Pintner had the great good fortune to examine another proglottid of the same worm and of about the same age as the others, which, superficially, exhibited nothing remarkable, but which, when a series of sections were made, revealed the astonishing fact that the penis of this proglottid had entered deeply into the vagina of the same joint. The most remarkable point in this case was the extraordinary depth to which the penis had entered the vagina, for it had passed the loop and reached as far as the level of the generative orifice.

These observations justify the assertion of the existence of typical cross-fertilization in the Cestoda, and, at the same time, confirm the much-discussed observations of Van Beneden and Leuckart on self-fertilization. They, further, strongly support the views of Zeller as to cross-fertilization in the Trematoda; as the same process has been observed in Turbellarians, it may be said to be common to all the Platyhelminthes.

The author has made some observations on the female generative organs of the Tetrabothriidæ, which may be thus summed up. In many, and probably in all Cestoda there is, at the commencement of the oviduct, and at the spot where it takes its origin from the membrane of the ovary, a muscular apparatus which has the function of pumping out the ova from the ovary or driving them on. This apparatus is well developed in the Tetrabothriidæ and Echinobothriidæ, but very feebly in the Tetrarhynchidæ, Tæniidæ, Bothriocephalidæ, and Ligulidæ; it appears to be derived from the similar arrangements which are so well developed in the Trematoda.

δ. Incertæ Sedis.

Heterogenesis in Rotifers.*—Dr. E. v. Daday has made some studies of *Asplanchna Sieboldi* which have shown him that the fertilized ova with thick membranes develope into tubular females, which in the course of their parthenogenesis give rise to an indefinite number of tubular and male-like females as well as males; after copulating with the last they lay fertilized ova, with thick membranes. The parthenogenetically developed male-like females give rise, by parthenogenesis, to other male-like and also to tubular females as well as to males; with the last they, finally, copulate and give rise to ova as before. In other words, *A. Sieboldi*, both parthenogenetically and after impregnation, gives rise to dimorphous females and to males, and after copulation to fertilized eggs. The author gives descriptions of the three forms of the progeny. It is difficult to compare this case exactly with any known mode of heterogenesis. It is probable that many of the forms described as distinct species are really heterogenetic representatives of other, already described species.

List of Queensland Rotifera.†—Mr. V. Gunson Thorpe gives a list of thirty-two species of Rotifera found on the Queensland coast. He hopes, at a later date, to publish descriptions of the new species which are not here enumerated.

* Math. u. Naturwiss. Berichte aus Ungarn, vii. (1890) pp. 140-56 (1 pl.).
† Proc. Roy. Soc. Queensland, vii. (1889) pp. 70-3.

Vibratile Tags of Asplanchna amphora.*—Mr. C. Rousselet states that there are about forty vibratile tags on each side; in shape they are like elongated and compressed cups; the cup is closed by a very delicate spongy protoplasm, probably quite open enough to allow part of the fluid of the body-cavity to pass through.

Notes on Rotifers.†—Mr. G. Western calls attention to a free-swimming *Lacinularia* which he calls *L. natans*, and to a new form resembling an *Asplanchnopus*, but apparently the type of a new genus, which he found in the river at Guildford.

Dinops longipes.‡—Mr. C. Rousselet applies this name to a Rotifer which has hitherto been placed with *Asplanchna*, but it has a distinct intestine and cloaca, and among the jaw-parts are the manubrium and uncus which are wanting in *Asplanchna*.

Organization of Cephalodiscus dodecalophus.§—Prof. A. Lang regards *Cephalodiscus* as, with *Balanoglossus*, a member of the Entero-pneusta. He looks on the organization of the latter as adapted to a limicolous and limivorous mode of life, and that of the former to a tubicolous and semi-sedentary one. Moreover, the organization of *Cephalodiscus* rests at a point which corresponds to an early stage of *Balanoglossus*. He does not, however, regard the form as a primitive one, but rather as an altered and simplified *Balanoglossus* which has been affected by its mode of life. The absence of the blood-vascular system may be connected with the small size of the body. Less weight is to be laid on the number of gill-clefts and gonads.

The resemblance of *Cephalodiscus* to the Bryozoa and to *Phoronis* is merely a convergence-phenomenon, due to adaptation to a similar mode of life. The presence of gill-clefts is a great obstacle to any thought of affinity, for even if the Bryozoa were regarded as being descended from *Cephalodiscus*-like forms, the disappearance of the gill-clefts would remain unexplained.

Anatomy and Histology of Phoronis.‖—Dr. C. J. Cori gives a long account of the structure of this animal, the systematic position of which has been so long a matter of doubt. He points out that the Phoronida and Bryozoa agree in the possession of a true cœlom; both have, at the anterior end of their bodies, a horseshoe-shaped crown of tentacles within which is set the mouth; this last may be closed by a lip-like process, the epistome; and, lastly, the anus always lies near the mouth.

The cœlom of both is divided into an upper and a lower portion by a partition stretched across in a direction transverse to the axis of the œsophagus. The upper cavity may be called the tentacular-coronal cavity, the lower the body-cavity; the former is made up of the cavities of the lophophore and epistome and of the tentacles. The body-cavity of the Bryozoa is an undivided space, but that of *Phoronis* is broken up by a number of enteric mesenteries. In the tentacular cavity there is on the anal side the ganglion, and from the same side there arises the

* Journ. Quek. Micr. Club, iv. (1891) pp. 241–2 (3 figs.).
† T. c., pp. 254–8 (1 pl.).
‡ T. c., p. 263.
§ Jenaische Zeitschr. f. Naturwiss., xxv. (1890) pp. 1–12.
‖ Zeitschr. f. Wiss. Zool., xli. (1890) pp. 480–568 (7 pls.).

epistome; the body-cavity, on the other hand, contains a pair of renal organs and the generative organs. The renal organs of both *Phoronis* and the Bryozoa agree in being short, ciliated tubes, with a retro-peritoneal course, which are, on the one hand, connected with the body-cavity by an infundibular orifice, placed anally of the œsophagus, and open to the exterior by an outer pore.

With regard to the differences between the Bryozoa and *Phoronis*, the phylactolæmatous division of the former has lophophoral arms; to this statement, however, *Fredericella* is an exception. Another difference, which appears to be important, is the absence of a blood-vascular system in the Bryozoa. This, however, may not be significant, as its absence is probably due to loss during phylogenetic development. In a young *Phoronis* the difference in the arrangement of the mesenteries is less unlike what obtains in Bryozoa than is the case with the adult. Although the author points out the resemblances between *Phoronis* and the Bryozoa, he does not go so far as those who regard the former as merely an aberrant Bryozoon; his object is merely to point out the genetic relations which appear to obtain between these two classes of animals.

Echinodermata.

Morphology of Bilateral Ciliated Bands of Echinoderm Larvæ.*—Dr. R. Semon is of opinion that the dipleural larvæ and *Tornaria* offer well-marked differences from the ciliated larvæ of higher and lower Worms, as well as of Molluscs. It would seem, therefore, impossible to homologize the circumoral ciliated band of Echinoderm-larvæ with the ciliated apparatus of other larval types. The structures have probably been acquired independently.

To make our judgment satisfactory we require, however, a better knowledge of the larval nervous systems than we have at present; it is certain that so highly differentiated a larva as *Bipinnaria*, with its rich and complicated muscular apparatus, must have a well-developed and, relatively speaking, highly developed nervous system. And of this we yet know but little.

Calamocrinus Diomedæ.†—Prof. A. Agassiz has a preliminary note on a new stalked Crinoid from the Galapagos. At first sight this new form might readily pass as a living representative of the fossil *Apiocrinus*, but it has also points of resemblance to *Millericrinus*, *Hyocrinus*, *Rhizocrinus*. Like these last, it has only five arms, but these are not simple, but send off from the main stem of the arm three branches to one side and two to the other. The system of interradial plates is highly developed, as in *Apiocrinus* and *Millericrinus*, six rows of solid polygonal imperforate plates being closely joined together, and uniting the arms into a stiff calyx as far as the sixth or seventh radial. These solid plates extend over the prominent anal proboscis; the oral plates are small. The stem is somewhat curved at the upper extremity; it tapers very gradually, and in its general appearance recalls that of *Apiocrinus;* it is cylindrical and has no cirri. There are five distinct basals in one specimen, in another the sutures can be recognized, and

* Jenaische Zeitschr. f. Naturwiss., xxv. (1890) pp. 16–25 (1 pl.).
† Bull. Mus. Comp. Zool., xx. (1890) pp. 165–7.

in the third the basals were completely ankylosed. The stem must have been 26 to 27 in. long, the arms about 8 in.; the height of the calyx to the interradials is 7/16 in.

Cœlenterata.

Development of Scyphostoma of Cotylorhiza, Aurelia, and Chrysaora.*—Prof. C. Claus deals with the developmental history of the three just-mentioned forms of Scyphomedusæ. In some important points Prof. Claus confirms the results of Goette, but in others he disagrees with him.

He finds that in *Cotylorhiza* embryonic development proceeds as far as the swarming Gastrula-stage within the egg-membrane. There is no irregular immigration of ectodermal cells into the blastula-cavity, but, as A. Kowalevsky has already described, the Gastrula is formed by invagination. Intermediate stages are presented by *Aurelia* between this mode and the ingrowth of a solid cell-mass which only later acquires a central cavity such as is seen in *Chrysaora*. The young Scyphostoma forms the proboscis at a very early stage; this organ is developed from the ectodermal invagination in such a way that the internal lining of the proboscis is permanently ectodermal. Some of the organs described by Goette are not developed either in *Cotylorhiza* or in *Chrysaora*.

In contradistinction to the Hydroid Polyps the young Scyphopolyp is characterized not only by the ectodermal nature of the lining of the proboscis, but by the appearance of four diverticula on the oral portion of the gastric cavity, which gives rise to the tentacles, as well as by the alternating rudiments of tæniolæ. In *Cotylorhiza* the tænioles remain rudiments, situated below the oral disc, and do not extend as longitudinal ridges over the whole length of the gastric space. The four septal muscles do not arise as in the Anthozoa, but as ingrowths of ectodermal cell-growths at the peristome, and they have only a secondary relation to the tæniolæ. The so-called septal funnels are cavities in the upper portion of these ectodermal growths, which may be continued into the septal muscles; in *Cotylorhiza*, however, they are not developed. They disappear on the conversion of the Scyphostoma-disc into the Ephyra. The development of the tentacles from the four-armed to the sixteen-armed form is irregular and essentially the same as that already described by the author. The sixteen-armed Scyphostoma appears as the normal form, although in *Aurelia* and other genera the number of tentacles, before the appearance of strobilation, may be as much as 24 or 32.

The conversion of the polyp-like tetrameral Scyphostoma into the octomeral Scyphomedusa commences with the formation of the circular series, of the lobed and intermediate pouches in the periphery of the same. The sensory knobs arise at the base of the eight radial tentacles. Prof. Claus is of opinion that reproduction by strobilation is a form of alternation of generation.

Hydra turned inside out.† — Prof. A. Weismann vindicates Ischikawa's experiments against Nussbaum's criticisms. When a *Hydra* is turned inside out and fixed by a bristle, it gradually rights itself.

* Arbeit. Zool. Inst. Wien, ix. (1890) pp. 85–128 (3 pls.).
† Arch. f. Mikr. Anat., xxxvi. (1890) pp. 627–38 (8 figs.).

Nussbaum and Ischikawa agree that ectoderm never becomes endoderm nor *vice versâ*. But Nussbaum seems to have explained the restitution of the everted polyp by an active migration of ectoderm cells; while Ischikawa showed that the *Hydra* righted itself after eversion by a genuine turning outside in. Ischikawa also demonstrated that endoderm cells were essential to the regeneration of a *Hydra* from a fragment, for the intermediary or interstitial cells cannot become endoderm. Weismann believes that the reason why an excised tentacle usually dies, and does not regenerate an organism, is not the absence of this or that kind of cell, but rather the small size of the fragment.

Spongicola and Nausithoë.*—Signor Lo Bianco and Dr. P. Mayer have been able to demonstrate by following out the development of the larva the correctness of Metschnikoff's suggestion that *Nausithoë* is a stage in the life-history of *Spongicola fistularis*. The Spongicolidæ are shown, therefore, to have nothing to do with the Hydroida, but to belong to the Acalephæ.

Porifera.

Comparative Anatomy of Sponges.†—In the third of his studies on the comparative anatomy of Sponges, Mr. A. Dendy deals with the anatomy of *Grantia labyrinthica* Carter and the so-called family Teichonidæ. Mr. Dendy is convinced that in the present transitional state of our knowledge of the Sponges anatomical investigation must precede systematic work; the greater the number of types investigated the greater will be the value of the ultimate scheme of classification. One great reason for this is that polymorphism and homoplasy occur so generally and to such an extraordinary degree among the Porifera that a careful examination of the internal anatomy is above all things necessary.

The structure of *G. labyrinthica* is described in detail and fully illustrated. It was first called *Teichonia* by Mr. Carter, and the family of which it is the representative the Teichonellidæ, which was altered by Polejaeff to Teichonidæ; in it that writer put his genus *Eilhardia*. As a matter of fact *Eilhardia Schulzei* Pol. and *Teichonella prolifera* Cart. are Leuconidæ and *G. labyrinthica* is one of the Syconidæ.

In his fourth study‡ Mr. Dendy deals with the flagellated chambers and ova of the common British Sponge, *Halichondria panicea*. The canal system is of the lacunar type, the lacunæ being so irregular as hardly to deserve the name of canals; the inhalant and exhalant lacunæ are precisely similar and interdigitate with one another in the most complicated and irregular manner. The flagellated chambers, which lie wedged in between one lacuna of each kind, are in a general way subspherical in form; their exhalant opening is very wide, and their diameter is about 0·047 mm.

The collared cells, when the chamber is seen in section, may be observed to stand some little distance apart from one another in the gelatinous ground-substance surrounding the chamber. Each cell has a short nucleated body, indistinguishable from the neck, and surmounted

* Zool. Anzeig., xiii. (1890) pp. 687–8.
† Quart. Journ. Micr. Sci., xxxii. (1891) pp. 1–39 (4 pls.).
‡ T. c., pp. 41–8 (1 pl.).

by the delicate funnel-shaped collar. These collars have extremely fine outlines, but all are connected at their margins by a very distinct membrane (Sollas' membrane). Neither Prof. Sollas nor Mr. Dendy have till now been able to see flagella in concrescent choanocytes, but Mr. Dendy has now been so fortunate as to see them plainly projecting from the bodies of the collared cells; he has thus decided the question of the coexistence of Sollas' membrane and the flagella of the collared cells. Bidder has already forestalled the author in a suggestion he was about to make—that this membrane serves to filter food-particles from the current of water flowing through the Sponge.

The ova are remarkable for their great complexity of structure. In *Grantia labyrinthica* the mature ova migrate through the walls of the inhalant lacunæ and remain suspended therefrom; each has its distinct peduncle and awaits the spermatozoa brought in by a stream of water. It is probable, though it has not been proved, that the lacunæ of *H. panicea*, in which the ova are found suspended, are also inhalant. The adult ovum has a total diameter of about 0·067 mm. The outermost portion forms a distinct envelope, which is fairly thick. Within this envelope the ovum proper is suspended as in a bag; it is spherical, uniformly and rather coarsely granular; the spherical nucleus has a very thick and distinct membrane, and the substance is finely granular, it stains lightly, whereas the substance of the single spherical nucleolus stains very deeply.

Protozoa.

Stentor cæruleus.*—Dr. A. Schuberg finds much to correct in previous descriptions of the structure of *Stentor cæruleus*. He gives his own observations on the superficial stripes, and their "ramifying zone," on the so-called "peristome" and its insunk oral region or "gullet," on the frontal region, and on the adoral membranellæ. In regard to the blue pigment, of which so little is known, he tells how some five-year-old preparations of this species had acquired the dark purple-red colouring of *St. igneus*, and how three living specimens which he isolated lost their pigment entirely and afterwards regained it. Schuberg has also discovered some new facts in regard to the process of division, and this especially, that the whole constriction is from the first connected with a rupture of the pellicle in a definite direction. In discussing the comparative morphology of *Stentor*, he maintains that the so-called peristome is not *in toto* homologous with that of other Infusorians, indeed that it is homologous with the "frontal region" of the Hypotricha and other Heterotricha, and should be renamed as such.

The Life of Difflugia.†—Dr. M. Verworn has found in *Difflugia lobostoma* an interesting object of study. In the specimens examined, the shell had no sand particles, but consisted of irregular plates made by the animal itself and of organic débris. It seems that the little plates arise from peculiar grains which lie round the nucleus and are probably formed as a secretion under nuclear influence. When an individual divides, these grains are exposed on the surface of the separated cell, unite firmly with one another, and form a connected case

* Zool. Jahrb., iv. (1890) pp. 197–238 (1 pl.).
† Zeitschr. f. Wiss. Zool., l. (1890) pp. 443–68 (1 pl. and 3 figs.).

of plates or scales. Verworn is strongly disinclined to believe that *Difflugia* exercises any "choice" in regard to the particles used in forming the extrinsic part of the shell. Thus in the basin whence his specimens of *D. lobostoma* were obtained, there were no sand particles, and consequently none on the shells. Moreover, he was able to see specimens clothing themselves with powdered glass when that was the only available material. The character of the shell depends mainly on what material can be most conveniently obtained, and on the mechanical conditions of architecture.

In studying the conjugation of *Difflugia*, unions of three and even four were repeatedly observed. The process is characterized by the appearance of a small, peculiarly shaped accessory nucleus beside the usual one, and during conjugation the small nuclei of two individuals come into close relations—facts evidently suggestive of what obtains in ciliate Infusorians. By numerous experiments on artificially divided specimens, Verworn has convinced himself that the nucleus is not a "psychical centre" of the cell, that normal movements persist for a time in portions without nuclei, and that these eventually cease because of molecular disturbances resulting from the absence of the nucleus, which has therefore an indirect but not a direct influence on movement.

Cytophagus Tritonis.*—Under this name Herr J. Steinhaus gives an account of a Coccidium which lives parasitically in the cells of the enteric epithelium of a Triton. The creature has the form of a small rounded cell which incloses a vesicular nucleus with a small nucleolus and some small pigment-grains. The diameter of the body varies from 2 to 9 μ. Proliferation commences with mitotic changes in the nucleus. After cell-division the products become sickle-shaped corpuscles, 6 to 7μ long; they become grouped in the cavity caused by the parasite in the body of the epithelial cell; they next take on an amœboid form, and wander from the cells in which they were produced. There is no cyst during any part of the period of proliferation.

In this last point *Cytophagus* agrees with the *Karyophagus Salamandræ* already described by the author, but the differences between them are such as to necessitate the establishment of a new genus for the parasite of the Triton.

Foraminifera collected off the South-west of Ireland.†—Mr. J. Wright gives a report on the Foraminifera collected in 1888 by the expedition sent out by the Royal Irish Academy, and concludes with a table of distribution of the 216 species of Foraminifera known from the south-west coast of Ireland.

* Centralbl. f. Bakteriol. u. Parasitenk., ix. (1890 [1]) pp. 50–2.
† Proc. Roy. Irish Acad., i. (1891) pp. 460–502 (1 pl.).

BOTANY.

A. GENERAL, including the Anatomy and Physiology of the Phanerogamia.

a. Anatomy.

Tschirch's Text-book of Anatomy.*—This volume, which serves as an introduction to a general work on Economical Vegetable Anatomy, embraces a discussion of the following subjects:—Structure of the cell, cell-contents, and reagents, including aleurone, chlorophyll, chromoplasts, fatty oils, starch and starch-generators, calcium oxalate, tannins, alkaloids, essential oils and resins, glucosides, &c.; formation and growth of the cell-wall, including a discussion of the so-called "intercellular substance"; different tissue-systems, adopting Haberlandt's classification; and a detailed account of secretion-receptacles.

(1) Cell-structure and Protoplasm.

Elementary Structures and Growth of the Vegetable Cell.†—Prof. J. Wiesner maintains that, since the cell-contents, such as chlorophyll-grains, &c., assimilate, grow, and multiply by division, the cell cannot be the ultimate elementary structure of the plant; it must inclose a number of simpler living structures, and may possibly consist of an organic combination of such structures. It is exceedingly probable that the protoplasm is itself made up of such elementary structures; it is itself organized, and, with its organized contents, nucleus, chlorophyll-grains, &c., can only multiply by division. For these living elements of the protoplasm which he formerly called plasmatosomes,‡ the author now proposes the simpler term *plasomes*.

Among the different kinds of plasome are to be reckoned the protoplasmic rudiments from which originate the chlorophyll-grains, the starch-grains, the vacuoles, the tannin-vesicles, and other similar structures, as well as the rudimentary structures from which the dermatosomes of the cell-wall are formed. The plasomes differ from one another as the cells of a tissue differ from one another; and they bear the same relation to the cell as the cells do to the tissue. Like certain cells, the plasomes appear to possess the property of uniting with one another, or of elongating into fibrils; or they may disappear by absorption.

In the lowest known organisms, such as the lower Schizophyta, the plasomes do not develope into separable products; in the lower Fungi, such as *Saccharomyces*, there are formed within the cell, from the plasomes, simply vacuoles and rudimentary nuclei, and the plasomes which constitute the cell-wall are so small that they cannot be recognized as dermatosomes. From the Algæ upwards the most various substances are formed out of the plasomes, but even in the highest plants all the

* 'Angewandte Pflanzen-anatomie: Bd. 1, Grundriss d. Anatomie,' 8vo, Wien u. Leipzig, 1890, xii. and 548 pp., 614 figs.

† SB. K. Akad. Wiss. Wien, xcix. (1890) pp. 383–9, and Ber. Deutsch. Bot. Gesell., viii. (1890) pp. 196–201.

‡ Cf. this Journal, 1886, p. 818.

plasomes of certain cells are ultimately employed only in the formation of cell-wall.

The functions of the plasomes are very various, and are not confined to the formation of the contents and of the cell-wall; their extreme minuteness and consequent large superficies greatly promote metastasis. They must be assumed to form a connected whole, which probably has a reticulate or scalariform framework, the interstices of which are filled with fluid, as is shown by the behaviour of protoplasts under the pressure of gases. Whether the plasomes are the ultimate organic structures of the cell cannot at present be determined; if they are so, they must be regarded as the carriers of all inherited characters, or the "pangens" of de Vries.*

The mode of growth of the plasomes differs, however, from that of protoplasm; the plasome increases simply by the growth of its mass, protoplasm by the fresh formation of growing plasomes.

Nuclear Origin of Protoplasm.†—M. C. Degagny, in a previous note on this subject, specially described the perforations which are produced across the nucellus, while in the present paper he deals with the consecutive formation of soluble ferments and of coagulable protoplasmic matters in the cell. The author takes as an example *Helleborus niger* (Christmas rose), and shows that these soluble ferments are the product of the cells in process of disorganization; a full understanding of the phenomenon is furnished by attentive observation of the tissues of the nucellus. In the Christmas rose there are certain nucelli where there are no perforations, and others where there are; there are certain nucelli where the embryo-sac in its growth assimilates the whole of the tissues which are in contact with it, without leaving any residue, and others where these tissues are not consumed by the sac. The author then carefully traces the formation of the soluble ferments, and states that these are not the only trace of liquid matter, but that in the perforations of the nucellus newly coagulated protoplasmic matter is also found. Several examples are then successively described which show clearly the actual course of the phenomena which the author describes; *Lilium candidum* is a favourable example.

(2) Other Cell-contents (including Secretions).

Distribution of the Organic Acids in Succulent Plants.‡—According to observations made by M. E. Aubert, chiefly on *Sedum dendroideum*, *Crassula arborescens*, and *Sempervivum tectorum*, malic acid is the only acid found in the free state in succulent plants, except occasional faint traces of tartaric. The quantity of malic acid varies greatly in different leaves of the same rosette (in the house-leek), and in the same rosette at different ages, being most abundant in the outer leaves. In the stem and leaves, the quantity is greatest at an early age, decreasing as the plants grow older; and as regards the distribution of the acid in the leaf itself, its proportion is least where the part receives most light, both

* Cf. this Journal, 1889, p. 547.

† Bull. Soc. Bot. France, xxxvii. (1890) pp. 180–8. Cf. this Journal, 1890, p. 196.

‡ Rev. Gén. de Bot. (Bonnier), ii. (1890) pp. 369–84 (5 figs.); and Bull. Soc. Bot. France, xxxvii. (1890) pp. 135–7.

heat and light causing its destruction. As a general rule, the maximum of acid corresponds to a minimum of aqueous vapour transpired, and *vice versâ*.

Tannin in the Compositæ.*—According to M. L. Daniel the organ in the Compositæ which contains the largest quantity of tannin is the leaf, next the capitulum, next the stem, and lastly, the root. The root is richest in tannin when young, while the reverse is the case with the stem and the leaves. Etiolation decreases the amount of tannin. The Cynaraceæ contain, as a rule, a larger quantity of tannin than the Cichoriaceæ. The above facts lead the author to the conclusion that, in the Compositæ, the tannins cannot play the part of reserve-substance like inulin.

Localization of the Essential Oil in the Tissue of the Onion.†—M. Voigt finds in various species of *Allium* that the essential oil of onion is found throughout the epiderm or the external layers of all parts of the plant, in the envelopes of the fruit and seed, in the layer of endosperm which surrounds the embryo, and in the sheaths of the vascular bundles. He believes its function to be to protect the plant in general against herbivorous animals, and especially the parts which conduct water and sap.

Occurrence and Function of Phloroglucin.‡—Herr T. Waage has detected the presence of this substance in about 135 species of plants. It is the symmetrical trioxybenzol, and occurs not only free, but forms also complex compounds, especially bodies of the nature of ethers, corresponding to the glucosides, such as phloroglucides (hesperetin, naringenin, phloretin, quercetin, rhamnetin, &c.), or phloroglucosides (aurantiin, glycyphyllin, hesperidin, phloridzin, rhamnin, rutin, &c.).

Phloroglucin is found chiefly in the following parts of the axis,—the epiderm, phellogen, phelloderm, cortical parenchyme, sclerenchyme, medullary rays (in Angiosperms), cambium, pith, aerial and root-hairs, endoderm, pericambium, root-cap, underground stems and roots, but not, or only to a much smaller extent, in the cork, bast-fibres, sieve-tubes, cambiform vessels, and wood-vessels; it was found also in the leaves, sepals, petals, stamens, and carpels. The proportion of phloroglucin varies greatly in different plants; as a general rule it is most abundant in Vascular Cryptogams, Gymnosperms, and dialypetalous Dicotyledons; least so in Monocotyledons and sympetalous Dicotyledons.

Phloroglucin $C_6H_6O_3$ may be formed, like the carbo-hydrates, by the mutual decomposition of carbon dioxide and water, with elimination of oxygen. It was never detected in the chlorophyll-grains or in the protoplasm of mature cells; only in the cell-sap. It is probably formed as the result of a splitting-up of sugar into phloroglucin and water. It appears not to be used up again to any extent in the vital processes of the plant, but to be a secondary product of metastasis.

* Rev. Gén. de Bot. (Bonnier), ii. (1890) pp. 391–403.

† Jahrb. Hamburgischer Wiss. Anlage, 1890. See Bonnier's Rev. Gén. de Bot., ii. (1890) p. 365.

‡ Ber. Deutsch. Bot. Gesell., viii. (1890) pp. 250–92.

(3) Structure of Tissues.

Apical Tissue in the Stem of Phanerogams.*—M. H. Douliot finds, from an examination of the stems of species belonging to about 20 genera of Gymnosperms (Abietineæ, Cupressineæ, Taxineæ, and Gnetaceæ), that the stem always grows, like that of Vascular Cryptogams, by means of a single apical cell, which is sometimes pyramidal, sometimes prismatic. It differs also from that of Monocotyledons and Dicotyledons in the absence of an independent epiderm. Among the 23 Monocotyledons examined, he finds two types, viz. (1) three distinct initial cells (Gramineæ, Commelynaceæ, Scitamineæ, Liliaceæ); (2) two distinct initials (Naiadaceæ, Juncaceæ, Alismaceæ, Hydrocharideæ). Among Dicotyledons, the existence of three initials is most frequent, occurring in two cases in Apetalæ, ten in Dialypetalæ Superiores, three in Dialypetalæ Inferiores, and almost universally in Gamopetalæ; while apical growth by two initial cells was observed in four cases among Apetalæ, five among Dialypetalæ Superiores, and in only one among Gamopetalæ.

Increase in Thickness of the Stem of Cucurbitaceæ.†—Mr. M. C. Potter finds that the stem of the woody genera of Cucurbitaceæ—*Cephalandra* and *Trichosanthes*—increases in the normal way by a well-marked interfascicular cambium. In the herbaceous climbers belonging to the order with annual stems, the stem is strengthened by a ring of sclerenchymatous tissue situated in the cortical tissue between the epiderm and the vascular bundles. The woody perennial climbers, on the other hand, have no ring of sclerenchyme, and derive their support mainly from the xylem, which is constantly being renewed from a cambium ring.

Morphological Origin of the Internal Liber.‡—M. Lamounette has investigated this subject chiefly in connection with the hypocotyl (tigellum), cotyledons, terminal bud, and leaves. With regard to the root and hypocotyl he finds that those plants examined which have an internal liber (phloem) in their stem, may be divided into two classes, viz. those in which this structure occurs in the hypocotyl, and those in which it does not; it never occurs in the root. The internal phloem of the hypocotyl is independent both of the phloem of the root and of the external phloem of the vascular bundles of the hypocotyl; its formation is always later than that of the external phloem, and of the xylem-elements of the vascular bundles in conjunction with it; it originates in the cells of the central medullary parenchyme. In the cotyledons the internal (upper) phloem is also always of later origin than the other elements of the vascular bundles, and originates in the procambial cells which have furnished these latter elements. Its period of formation and its origin are the same in the leaves.

Since therefore the formation of an internal phloem is abnormal, and is due to a special evolution of certain parenchymatous cells, and is independent of the formation of the fibro-vascular bundle with which it is associated, the author considers that the term "bicollateral," usually

* Ann. Sci. Nat. (Bot.), xi. (1890) pp. 283–350 (7 pls. and 5 figs.).
† Proc. Cambridge Phil. Soc., vii. (1890) 5 pp. and 2 pls.
‡ Ann. Sci. Nat. (Bot.), xi. (1890) pp. 193–282 (3 pls.).

applied to such bundles, ought to be disused, from the point of view of the origin of the internal phloem.

Formation of Duramen.*—According to Herr K. v. Tubeuf the excretion of gum or the formation of thyllæ in the vessels of dicotyledonous trees affords no analogy to the excretion of resin in Conifers. The purpose of the formation of duramen as a consequence of injury to the stem is the prevention in the interior of the plant of differences in air-pressure, in the proportion of oxygen, and in that of moisture, between the air within the plant and the external atmosphere. The substances which cause the hardening always arise from living cells, and the walls of the duramen are always impregnated with tannin.

Medullary Rays.†—Herr L. Kny has investigated the histological structure of the medullary rays of dicotyledonous woody plants. He finds them to be composed essentially, in the majority of cases, of two kinds of cell, which he calls medullary palisade-cells and medullary merenchyme-cells, and describes in detail their character in the case of *Salix fragilis*. The former are usually greatly elongated in their longitudinal diameter, and lie close together without intercellular spaces; the latter are usually elongated radially, and have narrow intercellular spaces lying transversely between their layers. In the case described, the innermost portion of the rays which lies in the region of the spiral vessels consists exclusively of palisade-cells. The two kinds of cell differ also in the mode of their punctation. The walls of the merenchyme-cells which are in contact with vessels are destitute of pits, while pits occur abundantly on their upper and under walls. Where, on the other hand, palisade-cells lie in contact with vessels, the intervening walls are provided with large polygonal slightly bordered pits, which are wanting in the palisade-cells of other parts of the medullary rays. Even in later rings belonging to branches several years old the merenchyme-cells are sometimes entirely wanting. Medullary rays consisting exclusively of merenchyme-cells were never seen by the author.

Function of the Sieve-portion of Vascular Bundles.‡—Dr. J. Blass adduces further arguments in favour of his view that the chief function of the sieve-tubes is the supply of food-material to the wood-elements and to the formative cambium. In many trees—*Tilia*, *Quercus*, *Syringa*, *Fraxinus*, *Populus*, *Betula*—as well as in herbaceous plants, he finds the sieve-cells in the immediate proximity of the cambium. By ringing the stems of both woody and herbaceous plants, it can be shown that no copious flow of albuminoids takes place out of the sieve-tubes.

M. H. Lecomte§ criticizes very unfavourably Dr. Blass's theory that the sieve-tubes are the locality of the formation, and not merely the conducting tissue, for albuminoid substances. He asserts that the theory rests on assumptions rather than on proved facts, and points out that it is opposed to other facts which have been established with regard to these vessels.

M. Lecomte further states that Dr. Blass does not pay sufficient

* Zeitschr. f. Forst- u. Jagdwesen, 1889, pp. 385–403. See Bot. Centralbl., xliv. (1890) p. 232. † Ber. Deutsch. Bot. Gesell., viii. (1890) pp. 176–88 (1 pl.).

‡ Jahrb. f. Wiss. Bot. (Pringsheim), xxii. (1890) pp. 253–92. Cf. this Journal, 1890, p. 622. § Journ. de Bot. (Morot), iv. (1890) pp. 299–300, 400–4.

attention, in describing transverse sections, to the distinction of the elements, or to the heterogeneous nature of their contents. Dr. Blass asserts that after decortication the contents of the sieve-tubes are identical above and below the decorticated portion. His critic, however, deems the observations on this subject to be incomplete.

Laticiferous System of Fumariaceæ.*—One of the characters hitherto relied on as separating the Fumariaceæ from the nearly allied Papaveraceæ is the absence of the laticiferous system so characteristic of the latter order. M. L. J. Léger shows that this distinction can no longer be maintained, although the nature of the latex is in general different from that of the Papaveraceæ. The laticiferous elements, which were found in all species of Fumariaceæ examined, take the form either of cells indistinguishable from those which surround them, or of more elongated cells, or of cylindrical or prismatic tubes with walls of their own, but never septated or branched. They occur in all organs of the plant,—in the root, hypocotyl, stem, leaves, bracts, calyx, corolla, and ovary; in the medullary parenchyme, the phloem of the vascular bundles, the cortical parenchyme, &c. The latex is usually limpid, without granules or globules, and of a gooseberry-red colour; but, in some species, as *Fumaria capreolata* and *speciosa*, it becomes yellow in the adult plant. On the other hand, some species of Papaveraceæ, e. g. *Eschscholtzia californica* and *tenuifolia*, as well as *Hypecoum procumbens*, intermediate between the two orders, have a red limpid latex resembling that of the Fumariaceæ.

Reserve-receptacles in the Buds of the Ash.†—From the structure of the bud-scales of *Fraxinus excelsior*, Herr F. Schaar draws the conclusion that they serve not merely for protection, but also as a supply of reserve food-material. The tissue which serves this purpose is a thick-walled parenchyme, the thickening-layers of which are absorbed, as the buds unfold, in the same way as a thick-walled endosperm-tissue. A similar nutritive tissue is found also at the point of insertion of the bud; and beneath the bud, in the pith of the branch, a local reservoir of starch, which disappears in the spring. The same is probably true of all buds the scales of which contain a thick-walled parenchyme.

(4) Structure of Organs.

Morphology of the Coniferæ.‡—Dr. M. T. Masters reviews in detail some points in the comparative morphology, anatomy, and life-history of the Coniferæ. The forms which have been described as constituting a distinct genus under the name *Retinospora* are only stages in the life-history of certain species of *Chamæcyparis*, *Thuja*, and *Juniperus*, and may possibly be the origin of new species. The number of cotyledons varies between two and as many as eighteen, and is inconstant, not only in some genera, but even in different individuals of the same species. Their usual form is linear or linear-oblong; the stomates on the cotyledons vary greatly in number; they are usually oval, with

* Comptes Rendus, cxi. (1890) pp. 843–6.
† SB. K. Akad. Wiss. Wien, xcix. (1890) pp. 291–309 (1 pl.).
‡ Journ. Linn. Soc (Bot.), xxvii. (1890) pp. 226–332 (29 figs.).

two guard-cells. Primordial or primary leaves often intervene between the cotyledons and the adult foliage-leaves; and the adult leaves may vary in different stages of the plant's growth or on different parts of its branches. The leaves not unfrequently exhibit movements, the purpose of which is apparently to secure the exposure of the stomatiferous surface to light and heat. The "needles" of *Pinus* are regarded by the author as true leaves. The "needles" of *Sciadopitys*, on the other hand, may probably be axial structures.

Dr. Masters adopts the gymnospermous view of the flowers of the Coniferæ, and also the hypothesis that each male "catkin" is a single flower. The number of pollen-sacs in an anther (microsporange) varies between two and as many as twenty. The form of the pollen-grain, whether winged or not, cannot be used as an absolutely certain character to distinguish between the Cupressineæ and the Abietineæ. In the female flower the fruit-scale is almost invariably present as something superadded to the bract; it may arise as an enation either from the base of the bract or apparently from the axis just within or above it: its structure is neither that of a leaf proper nor that of an ordinary shoot, but bears more resemblance to that of a cladode.

Theory of Pseudanthy.*—Prof. F. Delpino argues that organogeny by itself is a very untrustworthy test for determining the morphological nature of organs. It is only the comparative morphology of the mature organ that can determine this. Applying the theory of pseudanthy, and in harmony with the evidence afforded by the course of the fibro-vascular bundles, as is well shown in *Alcæa rosea*, he traces the descent of the Malvaceæ from a type allied to *Ricinus*, the staminiferous bodies of this latter genus having become converted into the staminiferous tube of the Malvaceæ, Bombaceæ, and Sterculiaceæ. The Hypericaceæ agree with the Malvaceæ in being pseudanthic, and in all other essential points, differing from them only in characters of secondary importance.

Staminodes of Parnassia.†—From an examination of abnormal flowers of *Parnassia palustris*, Dr. R. von Wettstein draws the conclusion that each staminode or nectary represents not a bundle of stamens, but a single stamen, the central branch corresponding to the filament, and all the branches on each side to an anther-lobe. This conclusion supports the view that the Parnassiaceæ are related to the Saxifragaceæ rather than to the Hypericaceæ.

Pollen-grains.‡—Herr H. Fischer has examined the structure of the pollen-grains in 2214 species of plants. In 1180 of these he finds the extine to present three parallel folds. The most complicated structure of the extine occurs in the Compositæ; it is much simpler in the Monocotyledones than in most Dicotyledones. The author could in no case detect the existence of a third membrane.

Tendrils of the Passifloraceæ.§—M. W. Russell states that there is great difference of opinion amongst botanists as to the nature of the

* Malpighia, iv. (1890) pp. 302–12 (1 pl.). Cf. this Journal, 1890, p. 623.
† Ber. Deutsch. Bot. Gesell., viii. (1890) pp. 304–9 (1 pl.).
‡ Beitr. z. vergleich. Anat. d. Pollen-körner, Breslau, 1890, 69 pp. and 3 pls.
§ Bull. Soc. Bot. France, xxxvii. (1890) pp. 189–91.

tendrils of the Passifloraceæ. The brothers Bravais considered the tendril to be an accessory bud; Masters held that it was the result of the partition of the floral peduncle; while Eichler described the tendril as an axillary branch of the leaf. The author has made most of his observations on *Passiflora holoserícea*, and draws the conclusion that the tendril of the Passifloraceæ represents a modified axillary branch.

Protection of Foliage against Transpiration.*—Prof. A. F. W. Schimper has studied this subject, especially in relation to the flora of Java. The protection against excessive transpiration afforded by the reduction of the surface and of the intercellular system, by a coating of resin or wax, by a thick cuticle, &c., is required not only by plants which grow in very dry situations, but also by halophytes, by Alpine plants, and in the colder temperate zones, by evergreen woody plants. This xerophilous character of the foliage is exhibited by the coast vegetation of Java—consisting of the mangrove, *Nipa fruticans*, *Casuarina*, *Cycas circinalis*, species of *Pandanus*, *Ipomœa pes-capræ*, &c., even when the soil on which they grow is frequently flooded. This structure is rendered necessary by the fact that the presence of salt in the substratum hinders the absorption of water, and that concentrated saline solutions in the green cells retard assimilation.

The same xerophilous character is presented by the alpine flora of Java, although the mountain-tops are never covered with snow, and the temperature is throughout the year favourable for vegetation. The principal determining causes appear to be here the rarity of the air and the powerful insolation, both of which have a tendency to promote transpiration. The evergreen trees and shrubs of temperate climates, such as the box, holly, ivy, conifers, &c., exhibit similar protective adaptation against excessive transpiration (and not against cold), in the thick cuticle, depressed stomates, &c.

Abnormal Leaves of Vicia sepium.†—M. W. Russell describes a modification in the structure of the leaves of *Vicia sepium* in consequence of the puncture of an insect, causing the transformation of the leaflets into ascidia. The puncture brings about an inequality in the growth of the cells of the two surfaces of the leaf, causing a folding of the leaflets on its median vein as on an axis.

Influence of the Moisture of the Air on the Production of Spines.‡—M. A. Lothelier has studied the causes which accelerate and retard the production of spines in two plants, namely *Berberis vulgaris* and *Cratægus oxyacantha*. The result of his observations is that the hygrometric state of the air exercises a marked influence on the production of spines in both the plants named. Dry air accelerates their production, while humidity retards it; and the internal differences correspond to the exterior. In a section of a spine exposed to moist air the vessels of the xylem are few in number, and the pericycle is not lignified; in dry air the xylem forms a continuous ligneous circle, and the pericyle is also lignified.

* SB. K. Preuss. Akad. Wiss., 1890, pp. 1045–62.
† Rev. Gén. de Bot. (Bonnier), ii. (1890) pp. 481–9 (4 figs.).
‡ Bull. Soc. Bot. France, xxxvii. (1890) pp. 176–8.

Aerial Roots of Orchideæ.*—Herr E. Palla describes the structure of the aerial roots in two species of Orchideæ, *Angræcum ornithorhynchum* and *Polyrhiza* sp.

In the former species the velamen is furnished with multicellular conical papillæ, having thickened walls, between which the velamen often consists of only a single layer of cells, thus greatly increasing the absorbing surface of these roots, which also serve as the assimilating organ. The leaves are very small and narrow, and of simple structure, only three vascular bundles passing into them.

In *Polyrhiza* the aerial roots have generally a triangular section, the velamen being well developed on the side in contact with the substratum, consisting there of several layers of cells, while it is more or less entirely suppressed on the two other sides. The velamen is furnished with hairs, which apparently serve both as absorbing organs and as organs of attachment.

β. Physiology.

(1) Reproduction and Germination.

Anatomical Characters of Hybrids.†—M. M. Brandza has examined the anatomical structure of the following hybrids, viz.:—*Rosa rugosa-fimbriata*, *Cornus tricolor* (*C. alba* + *C. mas*), *Cirsium arvense-lanceolatum*, *Marrubium Vaillantii* (*M. vulgare*+*Leonurus cardiaca*), *Medicago falcato-sativa*, and *Sorbus hybrida* (*S. Aucuparia* + *S. Aria*); and, while the characters are in each case constant, he finds the following remarkable differences between them. In (1) none of the characters of the hybrid are intermediate between those of the parents, but some of the characters are those of one parent, while others are those of the other parent. In (2) the stem, petiole, and principal veins of the leaf are intermediate in character between those of the parents, while the lamina presents some of the characters of each parent side by side. In (3) the stem and floral axis exhibit intermediate characters, while the petiole has some characters of each parent unchanged. In (4), as in (1), there is no blending of characters, but some of those of each parent are presented side by side. In (5) and (6) the structure is intermediate.

Proterandry and Proterogyny.‡—According to observations made by Mr. T. Meehan, the proterandry or proterogyny of a species is a point frequently governed by the conditions in which it grows. Thus, in the case of the hazel, while in this country the male and female flowers mature nearly simultaneously, in America, with sudden high temperature, the male flowers will open long before the female flowers, while with long-continued temperate heat, the female flowers will advance more rapidly than the male.

Flowers and Insects.§—Continuing his observations on the mode of fertilization and the fertilizers of American plants, Mr. C. Robertson

* SB. K. Akad. Wiss. Wien, xcviii. (1889) pp. 200–7 (2 pls.).
† Rev. Gén. de Bot. (Bonnier), ii. (1890) pp. 433–45, 471–9 (39 figs.).
‡ Proc. Acad. Nat. Sci. Philad., 1890, pp. 268–70.
§ Bot. Gazette, xv. (1890) pp. 199–204. Cf. this Journal, 1890, p. 628.

now describes in this respect several species of Papilionaceæ, the visitors being chiefly Hymenoptera and Diptera, with, in one case, a humming-bird. Several species have extra-floral nectaries.

Self-fertilized Flowers.*—Mr. T. Meehan records the following native or naturalized American plants as self-fertilized:—*Trichostema dichotomum*, *Buddlea curviflora*, *Vitex Agnus-castus*, *Hypericum mutilum*, *H. canadense*, *Phytolacca decandra*, *Lycopersicon esculentum*, *Lycopus virginicus*, *Hamamelis virginica*. He states that whenever a plant is unusually productive, he finds, as a rule, arrangements for self-fertilization.

Pollination of the Mistletoe.†—Dr. C. A. M. Lindman confirms the statement of Loew that the mistletoe is pollinized by insects; besides bees, he believes that flies are also attracted by the scent of the flowers, which he compares to that of apples, and which is strongest in the male flowers. Although the flowers themselves are inconspicuous, the yellow colour of the tips of the perianth-leaves, and of the thick internode beneath the flowers, makes the inflorescence visible for a considerable distance. In the male inflorescence, in addition to the normal terminal flowers, there are solitary flowers, which are larger than the normal ones, in the axils of the small bracts at the base of the inflorescence.

Pollination of Aristolochia, Salvia, and Calceolaria.‡—Herr C. Correns describes in detail the biological anatomy of the flowers of a number of species belonging to these three genera. In *Aristolochia Clematitis* he enters minutely into the structure and origin of the "wicker-hairs" (Reusenhaare) within the perianth-chambers, and the part played by them in insuring pollination. Similar hairs occur in other species of the genus, but are wanting in *A. sipho*, where the perianth-tube is curved, instead of being straight, as in the other species described. The exact mode of pollination in this species must remain undetermined until its insect-visitors have been observed in its native country.

In the different species of *Salvia* there are two mechanical contrivances for assisting pollination by insects, the lever-apparatus of the stamens, and the motility of the upper lip of the corolla. In those in which the latter contrivance is found, the stamens are entirely concealed in the upper lip, and the ordinary are frequently accompanied by cleistogamous flowers. In *S. pratensis* and its allies we have also, in addition to the hermaphrodite, smaller female flowers. The lever-apparatus in the larger flowers is described in detail. In the opinion of the author the viscid glands found on the corolla, stamens, &c., of many species, cannot serve, as Delpino thinks, the purpose of more firmly fastening the pollen-grains to one another.

In some species of *Calceolaria* we find a motile connective and a lever-apparatus somewhat resembling that of *Salvia*. On the outer side of the incurved margin of the lower lip of the corolla, are a number of hairs with glandular apical cells, and the pedicel-cells filled, in some species, with very brightly coloured chlorophyll-grains, but no starch.

* Proc. Acad. Nat. Sci. Philadelphia, 1890, pp. 270–4.
† Bot. Centralbl., 1890, pp. 241–4. Cf. this Journal, 1890, p. 745.
‡ Jahrb. f. Wiss. Bot. (Pringsheim), xxii. (1890) pp. 161–252 (5 pls. and 2 figs.).

Pollination of Crambe maritima.*—Dr. P. Knuth describes the structure and arrangement of the male and female organs in the wild sea-kail, and the arrangements for pollination. Although slightly proterogynous, he considers that, as a rule, the stigma is self-pollinated by the aid of small Coleoptera attracted by the abundant and strongly scented nectar contained in the honey-glands at the base of the stamens.

Change in Colour of the Flower of the Horse-chestnut.†—The inflorescence of the horse-chestnut consists of flowers, some of which are hermaphrodite, but the greater number male from the abortion of the style. On the upper petals are patches which are at first pale yellow and comparatively inconspicuous, but which, when the flower begins to wither, become bright red and much more conspicuous. Herr W. O. Focke has investigated the object of this change of colour, and has come to the conclusion that it is of no advantage to the individual flower, the small insects which are attracted by it taking no part in the process of pollination; its sole purpose seems to be to render the entire inflorescence more conspicuous to the humble-bees which are the principal fertilizers of the flowers.

Oospores formed by Union of Multinucleated Sexual Elements.‡—M. P. A. Dangeard finds that the young oogone of *Cystopus candidus* contains several nuclei; these do not fuse into one with the nuclei of the antherid, and there is no fusion of male and female nuclei. The so-called nucleus is an oily globule, completely soluble in chloroform, and it is surrounded by a layer of protoplasm which contains numerous nuclei. As the author has made similar observations on *Ancylistes*, *Saprolegnia*, *Pythium*, and *Peronospora*, he thinks his results may be generalized; the theory, therefore, of Fisch, that there is a fusion of nuclei in oospores formed by the union of multinucleated sexual elements, must be given up.

Germination of Seed of Castor-oil Plant.§—Prof. J. R. Green has been led by his study of *Ricinus communis* to the following conclusions:—The reserve-materials in the endosperm consist of oil and proteid matters, the latter being a mixture of globulin and albumose. The changes in germination are partly due to ferment action, and there are three ferments in the germinating seed; one is proteolytic and resembles trypsin, one is a glyceride, and splits the oil into fatty acid and glycerin, while the third is a rennet ferment. Two, if not all three, are in a zymogen condition in the resting seed, and become active in consequence of the metabolic activity stirred up in the cells by the conditions which lead to germination. The changes caused by the ferment action are followed by others, which are due to the metabolism of the cells, and on these the embryo exercises some influence by setting up, as it developes, a stimulus which is probably physiological. The result of the various processes is to bring about the conversion of the proteids into peptone, and, later, into asparagin, and the splitting of the oil into fatty acid and glycerin;

* Bot. Centralbl., xliv. (1890) pp. 305–8 (2 figs.).
† Abhandl. Bot. Ver. Brandenburg, xxxi. (1890) pp. 108–12.
‡ Comptes Rendus, cxi. (1890) pp. 382–4.
§ Proc. Roy. Soc. Lond., xlviii. (1890) pp. 370–92.

the latter gives rise to sugar, and the former to a form of vegetable acid which is soluble in water and in ether, is crystalline, and has the power of dialysis.

Germination of Seeds of Papilionaceæ.*—According to Sigg. O. Mattirolo and L. Buscalioni, when the seeds of Papilionaceæ (*Phaseolus multiflorus*, *Vicia Faba*, *Pisum sativum*, *Lupinus albus*) germinate, or are brought into contact with water, the process can be divided into three periods, viz.:—(1) The seed increases in size, causing a wrinkling of the integument, the absorption of water by which is the cause of the increase; cavities are formed between the integument and the cotyledons, and in the intercellular spaces of the integument itself, in which the air necessarily becomes rarefied. (2) A period of decrease in size due to the absorption of the air in the intercellular spaces. (3) This is followed by a second period of increase in size due in part to decomposition. The micropyle, which can open or close according to the hygrometric conditions, is the natural channel through which air enters the seed; and the integument of the seed plays a most important part in the respiration which is essential to its germination.

Germination of the Sugar-cane.†—Dr. Fressanges describes and figures an instance of germination of the grain of the sugar-cane while still within the panicle. The mode of germination has never been accurately described.

Temperature of Tubercles during Germination.‡—M. H. Devaux gives the results of some observations on the temperature of a mass of germinating potatoes. At the height of 30 cm. from the bottom of the heap the temperature was little in excess of that of the surrounding air; at 60 cm. the temperature was 23° C., the air being 20° C. At 130 cm. it was 29° C., while at the top of the mass, at about 2 metres, it was 39° C.

(2) Nutrition and Growth (including Movements of Fluids).

Absorption of Nitrogen.§—From experiments made in cultivating poppies and wheat in sterilized sand, M. Pagnoul concludes that ammoniacal nitrogen can be assimilated by plants when the nitric fermentation is deficient; but that it is notably inferior in this form to nitric nitrogen from the point of view of the nutrition of the plant.

Assimilation of Nitrogen by Robinia.‖—By causing seeds of *Robinia Pseudacacia* to germinate in a soil and a nutrient fluid entirely destitute of nitrogen-compounds, Herr B. Frank convinced himself that this leguminous tree possesses the same property as the herbaceous plants belonging to the order, of extracting nitrogen directly from the atmosphere. Tubercles were abundantly formed on the root, and, during the first summer, the seedling had obtained an amount of nitrogen 38-fold greater than that contained in the seed, nearly the whole of which must have been derived from the nitrogen of the atmosphere.

* Malpighia, iv. (1890) pp. 313–30 (6 pls.). Cf. this Journal, 1890, p. 625.
† Rev. Hist. et Litt. de l'Ile Maurice, April 23, 1890 (1 pl.). See Journ. of Bot., xxviii. (1890) p. 303.
‡ Bull. Soc. Bot. France, xxxvii. (1890) pp. 168–70.
§ Comptes Rendus, cxi. (1890) pp. 507–9.
‖ Ber. Deutsch. Bot. Gesell., viii. (1890) pp. 292–4.

Conduction of Water.*—Pursuing his investigations on this subject, Herr T. Bokorny finds that, in the case of *Myriophyllum proserpinacoides*, air and water are always present in the scalariform and spiral vessels of the vascular bundles. In addition to the vessels, the conduction of water appears to take place mainly through the outer and collenchymatous portion of the bast, but chiefly through the former. Experiments with iron-salts show that in this case the course of the ascent of water is through the wall of the vessels.

By the same method of investigation the same author † demonstrates that in *Rumex longifolius* and other species of the order, the transpiration-current passes through the cell-walls of the collenchymatous tissue of the leaf-stalk to the transpiring lamina of the leaf, and with a rapidity of not less than 1 metre per hour. The collenchymatous tissue is here distinguished by the great elongation of its cells.

Herr Bokorny ‡ further defends himself from the charge that he does not assign to plants any tissue with the special function of conducting water; what he does maintain is that there is no tissue which has always and exclusively this function in all plants.

(3) Irritability.

Sensitiveness of Plants to certain Salts.§—M. G. Ville points out that the sensitiveness of plants to certain salts may be used as a test for the presence of these latter. That the test is a delicate one may be easily inferred from the results obtained by the author in various plants with phosphate of lime.

Beer yeast gave very astonishing results, the presence of 0·0005 gr. dissolved in 1 litre being easily seen from its results on the growth of the yeast. Analogous results were obtained from experiments made with peas and wheat.

The experiments show the value of phosphate of lime as a manure or a necessary nutriment for perfect development, but their use as a test for this salt seems rather doubtful.

(4) Chemical Changes (including Respiration and Fermentation).

Physiology of Woody Plants.‖—Dr. A. Fischer finds that in summer the vessels of many dicotyledonous and monocotyledonous trees and the tracheids of conifers exhibit a decided glucose-reaction, while in about the same number the reaction is very slight or altogether wanting; the glucose does not occur in the wood-fibres. Dwarf shrubs and herbs contain no glucose in their stem, root, or leaf-stalks. In the winter the quantity of glucose sensibly diminishes, increasing again in the spring during the period of blossoming. The quantity of starch in trees shows one maximum in the autumn when the leaves begin to fall; after the fall of the leaves it decreases, reaching a minimum in the winter; it is formed again in the early spring, reaching a maximum about April, and then again decreasing, to be stored up again in the summer. In the

* Jahrb. f. Wiss. Bot. (Pringsheim), xxi. (1890) pp. 505–19. Cf. this Journal, 1890, p. 484.

† Biol. Centralbl., x. (1890) pp. 321–3.

‡ Bot. Ztg., xlviii. (1890) pp. 493–5.

§ Comptes Rendus, cxi. (1890) pp. 158–61.

‖ Jahrb. f. Wiss. Bot. (Pringsheim), xxii. (1890) pp. 73–160.

buds also important changes take place in the amount of starch stored up in them in the winter. In most dicotyledonous and monocotyledonous trees, especially those with hard wood, the reserve-starch remains unchanged in the wood and pith from the autumn till May; while in conifers and soft-wooded trees, such as the lime and birch, either the whole or the greater part of the starch is transformed into a fatty oil, or a portion of it in the bark into glucose. The carbohydrates formed in the leaves descend only through the cortex.

Physiological Researches on the Floral Envelopes.*—M. G. Curtel states that he has noticed that the flower, and the corolla in particular, carries on in darkness, or in a feeble light, a more active transpiration than does the leaf. This the author proves by experiments with *Cobæa scandens*. The intensity of the respiration is in like manner greater than that of the leaf, the quantity of oxygen absorbed being considerably in excess of the carbon dioxide given off. A great number of flowers contain chlorophyll in their perianth; sometimes the process of assimilation may be noted by the disengagement of oxygen, but more often the assimilatory process is masked by the respiration. It will be seen then that the general result is an energetic oxidization of the floral perianth, one of the consequences of this being that coloured substances are formed from the chlorophyll, which give to the floral envelopes their characteristic brilliancy.

Formation of Calcium Oxalate.†—Dr. F. G. Kohl supports the view of Palladin ‡ that oxalic acid must be regarded as a secondary product in the synthesis of albumen from amides and carbohydrates. Although it has not yet been detected in all cases, it is probable that all Algæ and Fungi, as well as Flowering Plants, produce oxalic acid or an organic acid that can physiologically replace it. Since the cells of fungi absorb very little, if any, lime, they cannot, of course yield crystals of calcium oxalate.

The production of oxalic acid by *Saccharomyces Hansenii*, already recorded by Zopf, may be regarded as an oxalic fermentation comparable to the acetic fermentation in being a process of oxidation. Dr. Kohl distinguishes two kinds of fermentation:—(1) oxidizing fermentation which results in the formation of acetic acid in the Schizomycetes, of oxalic and carbonic acid in Fungi, Algæ, Muscineæ, Vascular Cryptogams, and Phanerogams, and of tartaric and malic acids in the higher plants; and (2) reducing fermentation, resulting in the production of alcohol by Schizomycetes and Fungi, and of lactic and butyric acids by Schizomycetes.

Reduction of Nitrates to Nitrites by Plants.§—M. E. Laurent states that many other organs of growing plants have the same property as that already known in the case of germinating seeds, of reducing nitrates to nitrites. This was determined in the case of tubers, roots, petioles, stems, peduncles, and young fruits. The purpose of this function appears to be to furnish the living cells with oxygen for the

* Comptes Rendus, cxi. (1890) pp. 539–41.
† Bot. Centralbl., xliv. (1890) pp. 337–44 (3 figs.). Cf. this Journal, 1890, p. 476.
‡ Cf. this Journal, 1888, p. 247.
§ Bull. Acad. R. Sci. Belgique, xix. (1890) pp. 478–85.

purpose of respiration. The most satisfactory test for the presence of nitrites was found to be the reaction with chloride of naphthylamin in the presence of hydrochloric and sulphanilic acids.

Influence of Anæsthetics on Respiration.*—Sig. A. Mori has investigated the effects of anæsthetics on the respiration of green plants in light and darkness. Light and the anæsthetic favoured, darkness and the anæsthetic hindered, the emission of carbon dioxide. He inclines to believe that the anæsthetic, acting in sunlight, suspends the synthetic function with which the chlorophyll is associated, and thus increases the amount of carbon dioxide liberated. In darkness the anæsthetic certainly hindered the general respiration, for the amount of carbon dioxide liberated was less than the normal.

Presence of a Diastatic Enzyme in Plants.†—Herr J. Wortmann is unable to accept the statement of Mayer and others, that a diastatic ferment is universally present in all parts of plants, and that this substance is as widely distributed as starch itself, and indispensable to its absorption. He maintains that not only can starch be absorbed without the assistance of diastase, but that diastase may occur where it can have no physiological function in connection with the absorption of starch.

For the demonstration of the presence of diastase, the author recommends that the part of the plant in question be extracted, after being thoroughly crushed, with an equal volume of water, and that, except where large quantities of starch, mucilage, or albuminoids are present, the extraction should not last over more than from two to three hours in the cold. The presence of diastase is then shown by its action on starch.

As the result of a very large number of experiments, Wortmann finds that in reserve-receptacles where great quantities of starch are stored up, such as seeds, tubers, and rhizomes, diastase is also present in considerable quantities; while, on the other hand, it is not present in assimilating leaves, the disappearance of starch from these organs not being in any way dependent on the action of diastase. In opposition to Krabbe,‡ he states that protoplasm can disintegrate starch-grains in precisely the same way as diastase, by the formation of pore-canals.

Oil-decomposing Ferment in Plants.§—From experiments made by Herr W. Sigmund, chiefly on the seeds of *Brassica* and *Ricinus*, he concludes that there exists in plants a ferment capable of decomposing the fatty oils, the fatty acid resulting from the decomposition being principally oleic acid. The operation of the ferment is very much slower and less energetic than that of the pancreatic secretion of animals.

Fermentation of Bread.‖—According to experiments made by Miss Katherine E. Golden with German yeast, both yeast and bacteria can separately raise bread, the yeast sometimes better than the bacteria; while in the ordinary making of bread they act together.

* Atti e Rend. Accad. Med. Chirurg. Perugia, ii. (1890) pp. 135–41.
† Bot. Ztg., xlviii. (1890) pp. 581–94, 597–607, 617–27, 633–54, 657–69.
‡ Cf. this Journal, 1890, p. 749.
§ SB. K. Akad. Wiss. Wien, xcix. (1890) pp. 407–11.
‖ Bot. Gazette, xv. (1890) pp. 204–9.

Fermentation of Cider.*—M. E. Kayser, in studying the fermentation of cider, directed his attention in the first place to the chemical aspect of the different French ciders. Although these showed obvious differences of alcohol, tannin, sugar, glycerin, acids, &c., no results sufficiently definite for practical purposes were obtainable. Another object in view was to examine the various forms of fermentation-fungi. For this purpose 120 Pasteur's flasks containing apple-juice were inoculated with single cells from pure cultivations. In the end the number was reduced to eleven species. In this examination the following points were taken into consideration: the form and size of the cells, the surface scum and the bottom deposit, the sensibility of the vegetation to acid and alkaline sugar solutions. The clearness, taste, and odour of the resulting liquid were also noted. In examining the various kinds of *Saccharomyces* the author adopted a modification of the method introduced by Hansen; that is, noting the temperature-curves during spore-formation. This method is stated to have furnished excellent results. In another series of experiments the author made use of seven kinds of yeast, either alone or in mixtures, and, as far as possible, under conditions similar to those adopted in the commercial manufacture of cider. The results, as might be expected, were various, some being good, others indifferent, and others bad. The addition of *Saccharomyces apiculatus* imparted a perfumed bouquet.

B. CRYPTOGAMIA.

Cryptogamia Vascularia.

Selaginella lepidophylla.†—Herr W. P. Wojinowic describes the phenomena connected with the closing up and opening out of this plant under the influence of drought and moisture. It is a purely mechanical process, depending on its hygroscopic properties, and on the form of the primary axis of the plant, which is sympodial, forming a corkscrew-like spiral.

Vascular Bundles of Isoëtes.‡—Sig. O. Kruch describes in detail the histology and development of the conducting bundle in the leaves of *Isoëtes*. It is collateral, and its phloem-portion consists of sieve-tubes and parenchymatous or cambiform elements, which generally become transformed, except at the base of the leaf, into mechanical elements. The grouping of the sieve-tubes differs in the different species. Their longitudinal walls are distinctly thickened and punctated. The sieve-plate is covered by a substance which gives the reactions of callus. The xylem consists, in the limb of the leaf, of a system of canals bounded by cells of a special character, and of a parenchyme, in which some annular or spiral tracheids are dispersed. The bounding cells are of considerable width, and have very thin radial walls. As regards the

* Annal. de l'Institut Pasteur, iv. (1890) p. 321. See Centralbl. f. Bakteriol. u. Parasitenk., viii. (1890) pp. 726–7.

† Beitr. z. Morph. Anat. u. Biol. d. Selaginella lepidophylla, Breslau, 1890. See Flora, lxxiii. (1890) p. 501.

‡ Nuov. Giorn. Bot. Ital., xxii. (1890) pp. 396–402; and Malpighia, iv. (1890) pp. 56–82 (4 pls.).

development of the bundles, the first elements to become differentiated are sieve-tubes, followed by the central tracheid of the xylem. The tracheids which are first differentiated are prismatic, with polygonal section, and are terminated by horizontal septa.

In all the species examined, in the portion of the leaf which runs from the glossopode to its insertion in the rhizome, the sieve-tubes are united into a single zone, and constitute the greater part of the phloem-arc. In the section of the ligule and in that of the sporange, the xylem consists simply of tracheids of irregular thickness, constituting a network, the meshes of which are occupied by very thin-walled cells.

Lycopodiaceæ.*—Prof. F. O. Bower gives a sketch of the structure of this order of Vascular Cryptogams, and of its relationship to the extinct *Lepidodendra*. He states that while the latter, which varied among themselves to a considerable extent as regards details, correspond in their most important characters to the *Lycopodium* of the present day, they yet differed greatly from them in several respects, of which the most notable are their size, the presence of secondary thickenings in the stem, and the greater sexual differentiation as shown by the presence of two kinds of spore, male and female.

Hymenophyllaceæ.†—Herr C. Giesenhagen has examined the sexual generation of several species of Hymenophyllaceæ, especially *H. caudiculatum*. The prothallium of several species of *Trichomanes* is distinguished by the formation of gemmæ, spherical cells elevated on the apex of a pedicel, which divide, and finally become detached from the pedicel, and develope into new prothalloid filaments. While the prothallium of *Trichomanes* is diœcious, that of *Hymenophyllum* is frequently monœcious. The prothallium of *T. radicans* may continue to grow for three years without producing antherids or archegones.

In the spore-producing generation, while many species are rootless, others produce adventitious roots. Some species have barren and fertile leaves of different structure; the sterile leaves are always simply pinnate. Most species of *Trichomanes* are distinguished by the occurrence in the stem of "stegmata," flat tabular cells containing a mass of silica in contact with their inner wall. A sclerenchymatous cortex is almost universal in the stem and root. *Trichomanes microphyllum* n. sp. belonging to the section Hemiphlebium, is the smallest known fern, with leaves not more than 7 mm. in length, each of which has a single terminal sorus. The stem is penetrated by a vascular bundle of the simplest possible constitution, consisting of a single tracheid surrounded by four or five cambiform cells. The purpose of the conducting bundle in the Hymenophyllaceæ appears to be to carry the nutrient material to the sori and other parts where it is required. The rootless species have root-like cauline shoots, which attach the plant, and serve for the absorption of nutrient material. While the stem-bundle is completely surrounded by a sclerenchymatous ring, in the leaf-veins the bundle is protected only by a layer of sclerenchyme above and below, and the nutrient material reaches it from the parenchyme of the leaf through the lateral openings.

* Proc. Phil. Soc. Glasgow, xxi. (1890) pp. 158–72.
† Flora, lxxiii. (1890) pp. 411–64 (4 pls.).

The author is of opinion that neither the anatomy nor the morphology of the Hymenophyllaceæ lends itself to the view that they present an archaic form from which all other ferns are derived.

Stem of Ophioglossaceæ.*—In contrast to the statement of other writers, and to his own previous view, M. P. Van Tieghem now regards the stem of all the genera of Ophioglossaceæ as monostelic in the tigellar portion, i. e. below the first leaf, and astelic (i. e. without any central cylinder) in the portion of the stem above the first leaf. The difference which is manifested between the two types of stem in the order—viz. that of *Ophioglossum* on the one hand and that of *Botrychium* and *Helminthostachys* on the other hand—consists really in this, that in the former case the vascular bundles are free or dialydesmic, in the latter case they coalesce laterally, or are gamodesmic. This astelic structure of the stem marks a divergence from the Filicineæ, and brings the Ophioglossaceæ nearer to the Equisetaceæ, where we have also the astelic structure, both dialydesmic and gamodesmic.

Algæ.

Symbiosis of Algæ and Animals.†—Mdme. A. Weber-Van Bosse and Prof. M. Weber describe the following new example of true or apparent symbiosis from the Dutch East Indies.

A filamentous alga, *Trentepohlia spongophila* n. sp., was found in a freshwater lake in Sumatra, imparting a green colour to the sponge *Ephydatia fluviatilis*, and producing zoospores. The alga alone appears to derive benefit from the commensalism, but the sponge does not suffer injury from the perforation of its tissue. This is, therefore, not an example of true parasitism, but is rather a transitional case between true symbiosis and parasitism.

True symbiosis was observed between a marine sponge belonging to the genus *Halichondria* and *Struvea delicatula;* the former growing to a larger size than usual when infested by the alga, which becomes somewhat modified and assumes the appearance of *Spongocladia vaucheriæformis.*

Marchesettia spongioides was found in symbiosis with a *Reniera.*

The authors enumerate the following as true examples of symbiosis:—*Struvea delicatula* with a *Halichondria;* *Marchesettia spongioides* with *Reniera fibulata;* *Spongocladia vaucheriæformis* with *Reniera fibulata;* *Oscillaria spongeliæ* with *Spongelia pallescens* and *Psammoclema ramosum.* The following are doubtful:—*Callithamnion membranaceum* with *Spongelia pallescens, S. spinifera,* and *Aplysilla sulfurea;* *Scytonema* with *Spongia otaheitica.* The following must be regarded as instances of parasitism:—*Thamnoclonium flabelliforme* on *Reniera fibulata;* the Floridea observed by Lendenfeld on *Dactylochalina australis;* *Thamnoclonium spongioides* and *Rhodymenia palmetta* on an undetermined sponge; *Trentepohlia spongophila* on *Ephydatia fluviatilis.*

* Journ. de Bot. (Morot), iv. (1890) pp. 405–10.

† 'Zool. Ergebnisse einer Reise nach Niederländisch Ost-Indien,' Heft i. pp. 48–71 (1 pl.) Leiden, 1890. See Bot. Centralbl., xliii. (1890) p. 118; and Ann. Jard. Bot. Buitenzorg, viii. (1890) pp. 79–94 (2 pls.).

Fucoideæ of Scandinavia.*—Herr F. R. Kjellman proposes the following new classification of the Fucoideæ :—

Cl. I. Cyclosporeæ.
Fam. 1. Fucaceæ (Cystosireæ, Himanthalieæ, Fuceæ).
Cl. II. Phæosporeæ.
Order 1. Zoogonicæ.
Suborder 1. Gynocratæ.
Fam. 1. Cutleriaceæ.
Suborder 2. Isogonicæ.
Fam. 1. Lithodermataceæ, 2. Laminariaceæ, 3. Sporochnaceæ, 4. Ralfsiaceæ, 5. Spermatochnaceæ, 6. Stilophoraceæ, 7. Chordariaceæ, 8. Elachistaceæ, 9. Myriotrichiaceæ, 10. Desmarestiaceæ, 11. Dictyosiphonaceæ, 12. Striariaceæ, 13. Encœliaceæ, 14. Sphacelariaceæ, 15. Ectocarpaceæ.
Order 2. Acinetæ.
Fam. 1. Tilopterideæ.

Two new genera are also proposed :—*Phæosphærium* founded on *Linkia punctiformis*, and *Physematoplea* on *Scytosiphon attenuatus*.

Sphacelariaceæ.†—Herr J. Reinke gives a monograph of the species hitherto known of this family of Phæosporeæ, with descriptions of four new genera. He now regards them as a distinct family from the Ectocarpaceæ, the genus *Isthmoplea* belonging to the latter, while *Lithoderma* is the genus of Ectocarpaceæ which exhibits the nearest affinity to the Sphacelariaceæ, and is perhaps their point of departure. A histological character by which the Sphacelariaceæ are distinguished from *Lithoderma*, *Ectocarpus*, *Isthmoplea*, and all other Phæosporeæ, is the black colour imparted to them by eau de Javelle. The growth in length of the axes is effected by the lengthening and transverse septation of the apical cell.

The family consists of ten genera, viz. *Battersia* gen. n. (1 sp.), *Sphacella* gen. n. (1 sp.), *Sphacelaria* (12 sp.), *Chætopteris* (1 sp.), *Cladostephus* (3 sp.), *Halopteris* (1 sp.), *Stypocaulon* (3 sp.), *Phloiocaulon* (2 sp.), *Anisocladus* gen. n. (1 sp.), and *Ptilopogon* gen. n. (1 sp.). *Battersia* forms a distinct section of the family, distinguished by its crustaceous habit, the fertile branches springing directly from the relatively very large basal disc, and these branches ending in unilocular sporanges. The only species, *Battersia mirabilis*, is at present known only from Berwick. *Sphacella subtilissima*, from the Balearic Islands, forms small dense cushions on *Carpomitra*, on which it is parasitic; on the erect slightly branched uniseriate branches are numerous unilocular sporanges. In *Anisocladus*, from South Africa and New Zealand, the normal branches are always barren, and the fructification is confined to short branched adventitious branches, in the axils of which are both plurilocular and unilocular sporanges. *Ptilopogon*, from New Zealand, also has both kinds of sporange, which are found only in the axils of the branches of tufted adventitious shoots. The plant is of

* 'Handbok i Skand. Hafsalgflora,' Th. 1, Fucoideæ, Stockholm, 1890, 103 pp. See Bot. Centralbl., xliv. (1890) p. 148.

† Ber. Deutsch. Bot. Gesell., viii. (1890) pp. 201–15 (3 figs.).

large size, and is differentiated into primary and secondary axes, and branched leaves.

New Genera of Algæ.*—In his monograph of the Algæ of South Georgia, Dr. P. F. Reinsch describes four new genera, one freshwater and three marine, viz.:—*Dermatomeris*, belonging to the Ulvaceæ, with a coriaceous-gelatinous thallus; *Stegastrum*, belonging to the Chordariaceæ, and near to *Myrionema*, epiphytic on *Porphyra*; *Melastictis*, doubtfully placed among the Chordariaceæ, a true parasite; and *Hydrurites*, probably allied to *Hydrurus*. In none of them were the organs of reproduction made out with certainty.

Conjugation of Spirogyra.†—According to Prof. G. Haberlandt the two corresponding conjugation tubes do not begin to be formed at the same time in *Spirogyra quinina*; it is sometimes the tube of the male cell, sometimes that of the female cell, that is first formed; and the place of formation of the later one is in all probability determined by the chemical excitation exerted by a substance exuded from the apex of the older tube. As the two tubes are not always formed exactly opposite to one another, one or the other has to bend in order that they may meet, and this curvature is also probably of a chemotropic character. The contraction of the protoplast of the female cell, and its conversion into a gamete are also the result of a direct excitation by the male cell.

Trentepohlia.‡—M. E. de Wildeman describes the species of *Trentepohlia* natives of the Dutch East Indies, including the following new species:—*T. Bossei*, *T. luteo-fusca*, *T. procumbens*. The classification of the species is that adopted in his previous papers.

Enteromorpha.§—M. E. de Wildeman has followed out the mode of growth of *Enteromorpha intestinalis*, and especially the formation of the branches. In addition to the larger branches which spring from the base of the plant, there are often a large number of small branches springing from its upper region. Each of these originates in a rounded cell larger than those which surround it, which divides by a succession of transverse divisions to form a row of cells, and these finally, at least in the apical portion, also divide longitudinally. These branches may then become detached, and grow into new plants.

Volvox and Eudorina.‖—Continuing his observations on *Volvox*, Dr. L. Klein states that the colonies of *V. globator* are exclusively non-sexual and monœcious (almost invariably proterogynous), while in *V. aureus* as many as twenty-one different combinations are possible, and actually exist. The oospheres, which can be distinguished with certainty from the parthenogonids only by their deeper colour before maturity, may, in certain cases, develope into daughter-colonies without impregnation. The author distinguishes two kinds of "*Sphærosira*-form" of *V. aureus*—the normal form in which the division of the

* 'Die Deutschen Polarexpeditionen,' vi. (1890) pp. 329-449 (19 pls.). See Hedwigia, xxix. (1890) p. 285.

† SB. K. Akad. Wiss. Wien, xcix. (1890) pp. 390-400 (1 pl.).

‡ Ann. Jard. Bot. Buitenzorg, ix. (1890) pp. 124-42 (3 pls.). Cf. this Journal, 1890, p. 490.

§ Notarisia, v. (1890) pp. 1115-21 (1 pl.).

‖ Ber. Naturf. Gesell. Freiburg, v. (1890) 92 pp. and 5 pls. See Bot. Centralbl., xliv. (1890) p. 319. Cf. this Journal, 1889, p. 558.

antherozoids begins only after leaving the mother-colony, and the *Endosphærosiræ*, which are always smaller, and in which mature bundles of antherozoids are formed before their escape. Of *Eudorina elegans* the author observed both tabular and spherical daughter-colonies, but was unable to determine whether they were male or non-sexual. The bundles of antherozoids he regards as male colonies.

Reproduction of Hydrodictyon.*—Dr. G. Klebs gives further details of his experiments on the conditions which determine the production of zoospores or of gametes in *Hydrodictyon utriculatum*. The nutrient solution employed imparts to all cells the most active tendency to the production of zoospores. In the dependence of the production of zoospores on light, *Hydrodictyon* presents a marked contrast to *Œdogonium* and other Algæ; but recalls the similar phenomenon in the growth and production of cellulose in *Zygnema*. The presence of oxygen is also essential to the formation of zoospores. The power of non-sexual multiplication which lies latent in every cell is dependent on the presence of a definite material element which the author terms the rudiment. The conditions for its perfect development are the presence of warmth, oxygen, organic nutrient substances, nutrient salts, light, and fresh water. Of these the nutrient salts are the most important.

Gametes can also be formed in all mature nets; the determining factors being not internal causes but external conditions. The most favourable is a 5 per cent. solution of cane-sugar, with absence of nutrient salts; glycerin produces the same effect; also glucose, milk-sugar, mannite, and erythrite; a moderately high temperature is also essential; but the formation of gametes appears to be almost independent of light.

By varying the conditions, as above indicated, one and the same net may be induced to form zoospores in one part, gametes in another part. The conditions under which one or the other tendency predominates are given in detail. While an interruption of growth tends to induce the formation of zoospores, and the suppression of the production of zoospores induces a tendency to the formation of gametes, the experiments afford no support to the hypothesis that the maturity of the cell is by itself favourable to the production of sexual elements.

New Genus of Siphoneæ.†—Prof. J. G. Agardh thus describes a new genus *Callipsyma*, belonging to the Udoteaceæ:—But slightly encrusted, and having the filaments which compose the entire frond constricted into oblong joints; those of the laminæ which proceed from the margin of the rachis dichotomous and laterally agglutinated; those of the stem slightly flexuose.

Fungi.

Behaviour of the lower Fungi towards inorganic nitrogen-compounds.‡ — According to Herr O. Loew formic aldehyde CH_2O is poisonous to fungi and other organisms, but some of its unstable compounds are not. Only such inorganic compounds of nitrogen can supply

* Flora, lxxiii. (1890) pp. 351–410. Cf. this Journal, 1890, p. 206.
† 'Till Algernas Systematik,' Lund, 1887, p. 65. Cf. this Journal, 1887, p. 998.
‡ Biol. Centralbl., x. (1890) pp. 577–91.

nutriment as are easily transformed in the cells into ammonia. The nearly related hydroxylamin, NH_2OH, is, on the other hand, highly poisonous. This substance has not the least effect upon ordinary dissolved albumen; while, even when dilute, it immediately kills living protoplasm. In the same way the diamids entirely prevent the formation and growth of Schizomycetes. While a 1 per mil. solution of sulphate, phosphate, or nitrate of ammonia kills *Spirogyra* in twenty-four hours, even a 10 per cent. solution has no injurious effect on the lower fungi. The elimination of free oxygen during putrefaction takes place only when the putrefying substance contains nitrates.

Trehalose in Fungi.*—M. E. Bourquelot states that among the saccharine substances met with in fungi there is one, namely trehalose, which attracts particular attention. The author has analysed two examples of young *Lactarius piperatus;* the first was treated with boiling water and the second was desiccated in the air. In the former trehalose was exclusively found and in the latter mannite. The disappearance of the trehalose had therefore taken place during the desiccation.

Saprolegniaceæ parasitic on Algæ.†—M. E. de Wildeman records the following species of Saprolegniaceæ parasitic on different Algæ:—*Aphanomyces phycophilus*, *Lagenidium Rabenhorstii*, and *L. entophytum* on *Spirogyra*, *Ancylistes Closterii* on *Closterium acerosum*, and *Lagenidium Zopfii* n. sp., allied to *L. entophytum*, on a species of *Œdogonium*.

Devœa, a new marine genus of Saprolegniaceæ.‡—After explaining the life-history of *Saprolegnia* and *Dictyuchus*, Dr. S. Lockwood describes, under the name *Devœa infundibuliformis*, a new type of Saprolegniaceæ parasitic on the scales of *Hippocampus heptagonus*. The thallus has the form of a funnel or cornucopia surmounted by a lid or opercule. Within this funnel are produced the zoospores, which appear to escape by a fissure in the side. The following is given as a diagnosis of the new genus:—Thallus an infundibuloid capsule or sporangial cell, the basal end an imperforate point, often a little curved, constricted or inflected at the rim, making the aperture about 4/5 of the diameter across the face. Fitting to this is a membranous cap or opercule, very variable in length and in the form of the posterior part. Inside the capsule is a hollow core of somewhat wavy or irregular parallel planes, their inner edges making a well in the middle of the capsule. The zoospores from these hymeneal lamellæ issuing into the well, and there swelling, the mass rises and lifts off the opercule, flows over the rim, and thus swarms from the mother-cell. Neither hyphæ nor mycele were observed.

Gymnoascaceæ and Ascomycetes.§—Prof. H. Zukal describes new species of *Gymnoascus* and *Microascus*, and two new genera allied to *Gymnoascus*, viz.:—*Aphanoascus*, in which the envelope of the fructification resembles that of *Gymnoascus* only until the spores are ripe, developing later into a close pseudo-parenchyme; the mode of origin of the asci, spores, and intermediate hyphæ corresponds closely to that in

* Comptes Rendus, cxi. (1890) pp. 534–6.

† Bull. Soc. Belge Microscopie, 1890, pp. 134–9.

‡ Journ. New York Microscop. Soc., vi. (1890) pp. 67–85 (3 pls.).

§ Ber. Deutsch. Bot. Gesell., viii. (1890) pp. 295–303 (1 pl.). Cf. this Journal, 1890, p. 366.

Gymnoascus. *A. cinnabarinus*, found on alligator's excrement, presents a connecting link between *Gymnoascus* and *Eurotium*. In *Chætotheca* the peritheces are depressed and hemispherical, thick-walled and not coiled, and are surrounded by long slender blackish thick-walled hairs; the pear-shaped or nearly spherical asci arise laterally or at the end of very delicate much-branched hyphæ; the spores are eight in an ascus, smooth, and lens-shaped.

Prof. Zukal holds there is no real analogy between the mode of formation of the ascus of the Gymnoascaceæ and that of the archicarp of *Eurotium*, &c. Its origin is simply an accumulation of protoplasm in a hypha, the apex of which then becomes coiled by circumnutation. He believes that the basal portion of the slender sterile hyphæ in the fructification of the Gymnoascaceæ serves for the conveyance of nutrient material to the ascogenous branches; and that the corresponding hyphæ in *Penicillium* perform the same function. The true Gymnoascaceæ—*Endomyces*, *Gymnoascus*, *Ctenomyces*, and *Penicillium* — excluding *Eremascus*, are in fact nearly allied to *Eurotium*, *Aphanoascus*, *Cephalotheca*, *Chætotheca*, and *Microascus*.

Disease of the Beetroot.*—M. E. Prillieux has been able to follow the various phases of a beetroot disease, the chief characteristic of which is that it causes the young leaves to dry up and become black. The disease has been attributed to a fungus named by Fuckel *Sporidesmium putrefaciens*. As, however, the figure published by Fuckel does not correspond to any of the forms observed by the author on the small black leaves at the heart of the beetroot, he deems these to be due to a fungus for which he proposes the name of *Phyllosticta tabifica*, which causes white spots on the petioles.

Black-rot of Grapes.† — In reference to the alleged identity of *Phyllosticta Labruscæ* and *P. Ampelopsidis* with *Lastadia Bidwellii*, Mr. B. T. Galloway finds that inoculation of either the berry or leaf of *Vitis* and *Ampelopsis* with pycnid-spores from berries or leaves of the grape infected with the black-rot gives no result; while inoculation of *Ampelopsis* or *Vitis*-leaves with ascospores from infected grape-berries resulted in the formation of pycnids and spores of *Phyllosticta Ampelopsidis*.

Fungi parasitic on Forest-trees.‡—Herr E. Rostrup gives a summary of his observations during the years 1883–1888 on the fungi which cause diseases on forest trees in Denmark. They relate chiefly to the following species:—

Melampsora pinitorqua (*Cæoma pinitorquum*), on *Pinus excelsa* and *Mughus*, connected genetically with the *Melampsora* on *Populus tremula*; *M. betulina*, much more injurious to *Betula odorata* than to *B. verrucosa*; *Peridermium Pini* includes three distinct species, *Coleosporium Senecionis* on various species of *Senecio*, and apparently also on *Campanula*, with its æcidio-form *P. Wolfii* on the leaves of various species of *Pinus* of the group *Pinaster*, *Cronartium asclepiadeum* on *Vincetoxicum officinale*, with

* Comptes Rendus, cxi. (1890) pp. 614–6.

† Bot. Gazette., xv. (1890) pp. 255–9.

‡ Tidsskr. f. Skovbrug, xii. (1890) pp. 175–238 (11 figs.). See Bot. Centralbl., xliii (1890) p. 353.

its æcidio-form *P. Cornui* on the stems and branches of *Pinus sylvestris*, and *C. ribicola* on the leaves of species of *Ribes*, with its æcidio-form on the stems and branches of *P. Strobus*; *Trametes radiciperda*, one of the most destructive parasites on pines and beeches; *Peziza calycina*, a saprophyte, and apparently not injurious; *Lophodermium Abietis* sp. n., on *Pinus excelsa*; *Nectria ditissima*, one of the most destructive parasites on beeches, ashes, and apple-trees; *Nectria cucurbitula* on pines; *N. cinnabarina*, a destructive parasite on limes, sycamores, maples, horse-chestnuts, and hawthorns; *Rossellinia quercina* on ashes, beeches, and maples; *Herpotrichia parasitica* (*Trichosphæria parasitica*) on *Pinus excelsa*; *Cryptospora suffusa* on alders; *Pestalozzia Hartigii* on seedling conifers and beeches; *Phoma pithya* (*P. abietina*) on *Pinus Douglasii* and *Abies excelsa*.

Development of the Hypogæi.*—Dr. R. Hesse completes his account of the development of the fructification of the Tuberaceæ, Elaphomycetes, and Hymenogastreæ, out of "swarmers." Both the envelope (peridium) and glebe are formed out of minute motile bodies, which gradually come to rest and become agglomerated into smaller or larger colonies, the septated hyphæ round which they group themselves being probably derived from similar elements. The so-called rhizines, and all other hypha-like structures which spring from the older peridia, are always formed by the union into chains of similar motile bodies. The "swarmers," of which glebe and peridium are alike composed, can be readily isolated by pressing in water; but can only be detected by an amplification of 1000 or more; the author believes them to be provided with a cilium at each extremity. The asci are also formed out of structures endowed with an amœboid motion which result from the conjugation of bodies of the same kind; they are not formed from the so-called "ascogenous hyphæ," but become attached to these hyphæ after their formation, and subsequently increase in size at the expense of the paraphyses which surround them. The real mode in which the spores are formed will be described in a future monograph of the order.

Classification of Lichens.†—In his monograph of the Lichens of Brazil, M. E. Wainio describes a number of new genera, and as many as 240 new species. He considers all the systems of classification of Lichens at present proposed to be founded on uncertain characters, especially that of the stromatic structure of the exciple; and regards the nature of the gonids as the character of the greatest importance in the establishment of primary groups; while the paraphyses afford excellent characters for the discrimination of genera and species. M. Wainio divides Lichens first of all into Discolichenes corresponding to the Discomycetes, and Pyrenolichenes corresponding to the Pyrenomycetes, the former of these being again divided into Cyclocarpeæ, Graphideæ, and Coniocarpeæ.

Preparing Wine-Ferments.‡—M. A. Rommier prepares his wine-ferments in the following manner. Grapes carefully chosen are crushed

* Bot. Centralbl., xliv. (1890) pp. 308–15, 344–51 (2 pls. and 2 figs.). Cf. this Journal, 1890, p. 649.

† Acta Soc. pro Fauna et Flora Fennica, vii. (1890). See Morot's Journ. de Bot., iv. (1890), Bull. Bibl., p. xcv. ‡ Comptes Rendus, cx. (1890) pp. 1341–3.

and placed in little flasks. It is advisable to prepare more flasks than are absolutely needed, in order to have a greater chance of obtaining one free from bacteria or mycoderm. When fermentation has been fairly started, the flasks are lightly shaken up, and one or two drops removed to inoculate flasks filled with clear and sterilized grape-juice. After repeating this several times in grape-juice the cultivations are made in water mixed with sugar and suitable salts. In this way the less vigorous ferments are eliminated, and finally *Saccharomyces ellipsoideus* only remains. The ferment is then preserved in small or large flasks containing grape-juice, or in infusions made from sterilized raisins. The flasks are closed by means of stoppered tubes, the ends of which are plunged in water. The stoppers are carefully sterilized.

In order to preserve some ferment after it is quite fermented, it is separated by decantation from the alcoholic liquid, and is then introduced into glass bulbs, which are afterwards closed with a spirit-lamp. To ordinary wines devoid of bouquet there may, by this method, be imparted quite an agreeable flavour or bouquet.

Uredineæ and their Hosts.*—M. G. Poirault gives a complete list of the plants natives of France, Belgium, and Switzerland, with the Uredineæ known to be parasitic upon them, whether in the uredo-, teleutospore-, or æcidio-form, distinguishing also whether the teleutospores germinate immediately, or only after a period of repose. The host-plants are arranged under their natural orders.

Himalayan Uredineæ.†—Completing his Descriptive List of the Uredineæ of the neighbourhood of Simla, Dr. A. Barclay describes the following new species:—*Uromyces Vossiæ* on *Vossia speciosa*, *U. Strobilanthis* on *Strobilanthes Dalhousianus*, *U. McIntirianus* on *Hemigraphis latebrosa*, *Phragmidium quinqueloculare on Rubus biflorus*, *P. incompletum* on *R. paniculatus*, *Melampsora Sancti-Johannis* on *Hypericum cernuum*, *M. Leptodermis* on *Leptodermis lanceolata*, *Coleosporium Plectranthi* on *Plectranthus Gerardianus*, *C. Clematidis* on *Clematis montana*, *Chrysomyxa Piceæ* on *Picea Morinda*, *Cæoma Mori* on *Morus alba*, and also a number of new isolated uredo- and æcidio-forms.

Herr P. Dietel ‡ describes a new genus of Himalayan Uredineæ, *Barclayella*, with the following diagnosis:—Teleutosporæ series pluriv. multicellulares formantes, promyceliis germinantes divisione transversali in sporidia quatuor disrumpentibus. Uredosporæ et æcidiosporæ ignotæ. The typical species *B. deformans* grows on the leaves of the young shoots of *Picea Morinda* (*Abies Smithiana*). The genus differs from the nearly allied *Chrysomyxa* and *Coleosporium* in the mode of formation of the sporids.

Uredo Vialæ.§—Prof. G. von Lagerheim describes in detail this new parasite of the vine in Jamaica. It attacks the under side of the leaves, but the spots attacked retain their green colour longer than the healthy parts. The uredospores are ovoid or pyriform, 20–27 μ long by 15–18 μ

* Journ. de Bot. (Morot), iv. (1890) pp. 229–34, 245–51, 307–15, 342–8.

† Journ. Asiatic Soc. Bengal, lix. (1890) pp. 75–112 (4 pls.). Cf. this Journal, 1890, p. 648.

‡ Hedwigia, xxix. (1890) pp. 259–70 (1 pl.).

§ Rev. Gén de Bot. (Bonnier), ii. (1890) pp. 385–90 (1 pl.). Cf. this Journal, 1890, p. 495.

broad; their membrane is thin and colourless, and is closely covered with minute elevations. Each group of uredospores is surrounded by a circle of cylindrical paraphyses swollen at the base. A variety or very nearly allied species, *U. Cissi*, attacks *Cissus rhombifolia*.

Æcidium esculentum.*—Under this name Dr. A. Barclay describes a fungus belonging to the Uredineæ which grows on the flowering shoots of *Acacia eburnea* in India, causing hypertrophy and other malformations; its æcidia are largely eaten by the natives.

Mycetozoa.

Development of Myxomycetes and new Species.†—Mr. G. A. Rex points out that, although the sporange of many mature species of Myxomycetes exhibits remarkable variation in form, colour, and structure, no such tendency to variation exists in the plasmodial stage, the plasmode itself being unvarying in colour and in other physical characters. The variations in the sporangial stage the author believes to be due to local external influences, especially to differences in the temperature and moisture of the atmosphere. The above remarks are illustrated especially in the case of *Tubulina cylindrica*.

The same author ‡ describes the following new American species of Myxomycetes:—*Physarum tenerum*, *Trichia subfusca*, and *T. erecta*.

Protophyta.

a. Schizophyceæ.

Vegetation of Hot Springs.§—Mr. W. H. Weed enumerates the Algæ found in the hot springs on the American continent. Of these there are no less than 3500 in the Yellowstone district, the temperature of which reaches 85° C., while in the Brewer-spring in California it rises as high as 93° C. They consist of peculiar species of Protococcaceæ, Oscillariaceæ, and Confervaceæ, with a comparatively small number of Desmidiaceæ and Diatomaceæ, generally the same species as in cold waters. They thrive best when the water is somewhat alkaline; their colour is often a bright red and green, and varies with the temperature of the water. They are always eventually encrusted by siliceous or calcareous sediment.

Zoochlorellæ and Lichen-gonids.‖—Herr M. W. Beyerinck gives further details of his pure culture of some of the lowest Algæ (Protophyta) Since the organism known as *Chlorococcum protogenitum* Rbh. does not appear to produce zoospores under any conditions, he proposes to establish it as the type of a new genus under the name *Chlorella vulgaris*. The cultures of this and of the new species *Raphidium naviculare* were made by introducing a drop of the water containing them into a nutrient fluid consisting of ordinary ditch-water boiled with 10 per cent. gelatin. *Scenedesmus acutus* cultivated in this way was found also to

* Journ. Bombay Nat. Hist. Soc., v. (1890) pp. 1–4 (1 pl.) See Bot. Centralbl., xlix. (1890) p. 322.

† Bot. Gazette, xv. (1890) pp. 315–20.

‡ Proc. Acad. Nat. Sci. Philadelphia, 1890, pp. 192–6.

§ Amer. Naturalist, xxiii. (1889) pp. 394–400.

‖ Bot. Ztg., xlviii. (1890) pp. 725–39, 741–54, 757–68, 782–5 (1 pl.). Cf. this Journal, 1890, p. 757.

liquefy gelatin, though more slowly than bacteria. The effect of this and other similar organisms on other nutrient substances is described in detail. *Chlorella* the author regards as belonging to the Pleurococcaceæ, and as presenting the lowest form from which the green algæ are derived; it belongs to the same type as *Eremosphæra*. Its identity was again demonstrated with the Zoochlorellæ of *Hydra viridis*, the green variety of *Stentor polymorphus*, *Paramecium aurelia*, and *Spongilla fluviatilis*; but the author's observations tend to show that *Raphidium* and *Scenedesmus* are perfectly distinct organisms from these. The genus *Chlorella* is defined as consisting of unicellular green algæ, with spherical, elliptical, or flattened cells, from 1–6 μ in diameter, usually with only one chromatophore, and no or only an inconspicuous pyrenoid; usually only one nucleus, or sometimes two, consisting only of chromatin; multiplication by free cell-formation from successive bipartitions; zoospores altogether wanting. It occurs in both fresh and salt water, and probably also on the soil. Four species are described:—*C. vulgaris* (*Chlorococcum protogenitum* Rbh.), *C. infusionum* (*Chlorococcum infusionum* Rbh.), *C.* (*Zoochlorella*) *parasitica* Brandt, and *C.* (*Zoochlorella*) *conductrix* Brandt.

Another form produced under similar circumstances is *Chorosphæra limicola*, which differs from those already described in readily producing zoospores; it bears a strong resemblance to *Chlamydomonas pulvisculus* in its structure and mode of life.

The gonids of the lichen *Physcia parietina* are identical with *Cystococcus humicola* Näg. They multiply by a series of bipartitions, or, under certain circumstances, produce zoospores closely resembling those of *Chlorosphæra*; no conjugation between these was observed.

Diplocolon and Nostoc.*—Pursuing his investigations on the metamorphoses which *Scytonema clavatum* undergoes when grown on a nidus of Hepaticæ, Herr H. Zukal found that filaments, when moistened after being accidentally desiccated, had become, as well as their enveloping sheath, distinctly shorter and thicker. These filaments eventually passed over entirely into the *Nostoc*-condition; or the trichomes became enveloped in thick yellow secondary sheaths, very often consisting of two distinct layers, and coiled in a loop-like fashion. In this condition they agree altogether with the characters of *Diplocolon*, which must be regarded as a condition of development connecting *Scytonema* with *Nostoc*. The *Diplocolon*-filaments finally passed over into *Nostoc microscopicum*.

Oscillariaceæ.†—M. M. Gomont gives a revision of the genera of the Homocystous Nostocaceæ (Oscillariaceæ) founded on the same principles as that of Bornet and Flahault for the Heterocystous Nostocaceæ,‡ and based on an examination of living and dried specimens, and of published descriptions. In accordance with these writers he uses the term *trichome* for the string of cells, and *filament* for the filament inclosed in its sheath, and proposes *cap* (coiffe) for the thickening often produced in the upper part of the membrane of the apical cell, and furnishing an

* Notarisia, v. (1890) pp. 1106–15 (1 pl.). Cf. this Journal, 1890, p. 222.
† Journ. de Bot. (Morot), iv. (1890) pp. 349–57.
‡ Cf. this Journal, 1890, p. 103.

organ of protection. It is wanting in the Heterocystous Nostocaceæ, and in the Homocystous genera protected by a thick sheath, as *Schizothrix* and some species of *Lyngbya*. Its structure is, however, often manifested only in the mature trichome before the formation of the hormogones. As a general rule the characters used for the discrimination of the genera are the number of trichomes, whether one or more, in the sheath, the form and consistency of the latter, and the grouping of the filaments among one another; while the anatomical characters of the trichome are chiefly employed for the distinction of species. The fourteen genera are thus classified:—

Tribe I. Vaginarieæ. Trichomes two or more in each sheath when the filaments are completely developed (with one exception); sheath yellow, red, or blue.

A. Sheath inclosing several trichomes. 1. *Schizothrix* (subgenera Inactis, Hypheotrix, Symphyosiphon, Chromosiphon). 2. *Dasyglœa*. 3. *Microcoleus*. 4. *Hydrocoleum*.

B. Sheath red, inclosing only a single trichome. 5. *Porphyrosiphon*.

Tribe II. Lyngbyeæ. Trichomes solitary in the sheath; sheath yellow, never red or blue.

Subtribe 1. Lyngbyoideæ. Trichomes naked and mobile only for a short time; hormogones secreting a new sheath when emerging from the one in which they were inclosed. 6. *Plectonema*. 7. *Symploca*. 8. *Lyngbya* (subgenera *Leibleinia*, *Eulyngbya*). 9. *Phormidium*.

Subtribe 2. Oscillarioïdeæ. Trichomes naked and mobile for the greater part of their existence; sheath delicate, fragile, not coloured, in some species wanting or not yet detected. 10. *Trichodesmium*. 11. *Oscillaria*. 12. *Borzia*. 13. *Arthrospira*. 14. *Spirulina*.

Classification of Diatoms.*—Sig. M. Lanzi proposes the following classification of the Diatomaceæ:—

Series I. Frustula axi infravalvari sæpius brevi, cingulo angusto et patente sculptura carente.

A. Valvæ absque linea longitudinali mediana.

a. Valvis rotundatis.

a. Sculptura simplice isomorpha (Melosireæ, Coscinodisceæ, Eupodisceæ, Chætocereæ).

b. Sculptura heteromorpha (Asterolampreæ, Heliopelteæ).

β. Valvis oblongis.

a. Frustula cingulo et valvis asymmetricis (Meridioneæ, Licmophoreæ, Surirelleæ).

b. Frustula et cingulo symmetricis, valvis asymmetricis (Eunoticæ).

c. Frustula cingulo valvisque symmetricis (Nitzschieæ, Fragilaricæ, Tabellarieæ).

B. Valvis linea et nodulo mediano præditis.

a. Frustula asymmetrica, cingulo recurvo dorsiventrali,

* Atti Acc. Pont. Nuovi Lincei, xliii. (1890) pp. 53–7. Cf. this Journal, 1890, p. 496.

valvis dissimilibus, una tantum lineam et nodulum medianum habens (Cocconeideæ, Achnantheæ).

β. Frustula symmetrica, valvis similibus (Gomphonemeæ, Cymbelleæ, Naviculeæ).

Series II. Frustula latere aucta, axi infravalvari longitudinalem æquante vel sæpius exsuperante, cingulo plerumque lato et patente sculptura prædito.

α. Cingulo simplice haud tesselato (Hemiauliideæ, Biddulphieæ).

β. Frustula cingulo late extenso, partibus pluribus prætextis composito (Striatelleæ, Rhizosolenieæ).

Nutrition and Movements of Diatoms.*—Dr. J. D. Cox adopts Van Heurck's view of the alveolation of the siliceous coat of diatoms, and believes that it is by endosmose through the alveolæ that they receive their nutriment. On the other hand he considers that the chief locomotive organ of diatoms is the raphe, when present, and that the habit of the species depends on the presence or absence, and on the position and form, of this organ. Thus, for example, the symmetrical *Naviculæ* are furnished with a well-developed raphe along the median line of each valve; *Cocconeis*, with its raphe situated on one side only of its large and flat disc, is adapted to an epiphytic life on the stems of other Algæ; the curved species of *Surirella* have no proper movement, except a slight rolling from time to time; their raphe is found on the border of the wings. Other Pseudo-raphideæ or Cryptoraphideæ are carried without resistance by waves and currents, or vegetate quietly in a bed of mucus, following a mode of existence in accord with the conditions by which they are surrounded.

β. Schizomycetes.

Prof. R. Koch on Bacteriological Research.†—In an address on bacteriological research, Prof. R. Koch gives a rapid sketch of the history of Bacteriology, the age of which is computed to be about fifteen years. After acknowledging that our present knowledge is in great measure due to, and in fact has been rendered possible by, the great improvements in Microscope objectives and in the methods of technique (preparation, preservation, cultivation, &c.), the author lays it down as being incontrovertible that all species of bacteria are constant, but admits that within certain limits they may deviate from the normal type, the pathogenic being most prone to variability. The confusion which has frequently arisen with regard to the species of bacteria is ascribed to the undue prominence given by some writers to certain characteristics, and it is held by the author that the proper method of determining the specific position of micro-organisms is to very carefully consider every characteristic, morphological and biological. And even when this has been done there are numerous difficulties to be overcome; for example, to isolate and identify the typhoid bacillus from the contents of the intestine, from the soil or water, is difficult even for the experienced observer.

* Journ. de Micrographie, xiv. (1890) pp. 207–12, 245–7.

† 'Vortrag gehalten in der 1. allgemeinen Sitzung des X. Internat. Med. Congresses 1890,' Berlin, Hirschwald, 1890, 8vo, 15 pp.

Yet with a few bacteria more certainty can be attained; cholera vibrios and tubercle bacilli possess specific characteristics by which they can be easily identified. But even in the case of tubercle bacilli a caution is necessary, for the author notes that the bacillus of fowl tuberculosis is obviously a distinct though closely allied species.

The next point discussed is the relation of bacteria to disease. The proof of a direct relation is perfectly clear with regard to a certain number of infectious diseases—anthrax, tuberculosis, erysipelas, &c. And as to some others, such as typhoid, cholera, diphtheria, relapsing fever, leprosy, there is little doubt, although the attempts at artificial infection have hitherto failed.

After alluding to the importance of the metabolic products of bacteria and the recently discovered toxalbumins, the author expresses his opinion that the question of immunity can only be answered by the aid of bacteriology, and then passes on to consider some of the biological phenomena of bacteria.

After this the numerous failures of bacteriology are touched on, as in measles, scarlet fever, typhus, small-pox, rabies, influenza, and numerous other infectious disorders.

The address concludes with a consideration of the methods at our disposal for combating pathogenic micro-organisms, either directly, as by disinfection, or indirectly, by the application of certain substances to the body which might render the bacteria inert, without injury to the organism.

Germicidal Action of Blood-serum.*—For ascertaining the action of the blood-serum of sick or vaccinated animals, MM. Charrin and Roger passed carotid blood of the rabbit into iced sterilized vessels, and inoculated the serum obtained after coagulation with *B. pyocyaneus*. This microbe has, according to Buchner, a marked resistance to the germicidal action of blood-serum. From comparative experiments between the serum of normal animals and those which 24 hours previously had received an intravenous injection of *B. pyocyaneus*, and which were moribund, when the blood was withdrawn it was found that the serum of the latter was more resistant. After 24 hours the tubes were no more cloudy than previously, and microscopically only a few isolated bacilli were found, while the normal serum had become turbid and contained numerous bacilli.

A resistance of intermediate intensity was shown by the serum of rabbits which had been repeatedly infected by the subcutaneous injection of *B. pyocyaneus*. Plate cultivations of the three kinds of serum showed great differences in the number of germs they contained.

The germicidal action, accordingly, is intensified in the serum of sick and vaccinated animals. The authors consider, however, that immunity is the result of manifold conditions, and do not intend to throw any doubt on phagocytosis.

The same authors † have recently extended their researches on the germicidal action of blood-serum to the bacillus of symptomatic anthrax

* Comptes Rendus, cix. (1889) pp. 710–3. See Centralbl. f. Bakteriol. u. Parasitenk., viii. (1890) pp. 283–4.

† CR. Soc. Biol., 1890, No. 14. See Centralbl. f. Bakteriol. u. Parasitenk., viii. (1890) p. 283.

("Rauschbrand"). As is well known, guinea-pigs are extremely sensitive to Rauschbrand, while rabbits are almost completely refractory. Yet these bacilli develope better in the blood-serum of rabbits than in that of guinea-pigs. By vaccination the blood-serum of both animals is found to have received increased germicidal properties; nor is this a transitory condition, for the authors observed it for seventy days. Hence for Rauschbrand no parallel can be drawn between the natural resistance of these animals and the germicidal property of their blood-serum.

Germicidal Action of Blood.*—Prof. J. von Fodor, after alluding to his first researches on the germicidal action of blood, the experiments and inferences of others on the exact value to be given to the plasma, the corpuscles, or the tissues in destroying bacteria, and therefore producing immunity for the organism, gives an account of some lengthy researches he has recently carried out on the same subject.

The bacterium employed was anthrax, and the blood of living animals was passed, with the usual precautions, into flasks containing glass beads. The blood was then defibrinated by shaking and afterwards inoculated with anthrax disseminated equally throughout the blood by means of the beads. At certain intervals some of this blood was inoculated on pepton-gelatin.

Only some of the results of the more important experiments can be mentioned. These were that arterial blood is more germicidal than venous; and fresh blood more so than that which has stood.

The germicidal action increases with the temperature, being strongest from 38°–40°, after which it rapidly diminishes.

Individual disposition to infectious diseases seems to be in exact proportion to the germicidal action of the blood.

By artificial modification of the blood, in other words by increasing its alkalinity, it was found that the germicidal properties would be considerably augmented. It therefore immediately followed that it might be possible, by increasing the alkalinity of the organism, to inhibit the growth of anthrax after inoculation, and experiments were made on rabbits with this intent, by injecting them with bicarbonate of soda. The results were sufficiently satisfactory to warrant a further and more prolonged investigation.

Certain Conditions that modify the Virulence of Tubercle-Bacillus.†—Dr. A. Ransome has made some experiments that go to show that fresh air, light, and a dry sandy soil have a distinct influence in arresting the virulence of the tubercle-bacillus; mere exposure to light in otherwise bad sanitary conditions does not destroy the virus.

Cure for Tetanus and Hydrophobia.‡—Mr. E. H. Hankin has a notice of a recent memoir by Behring and Kitasato, two workers in Prof. Koch's laboratory, who have not only succeeded in producing immunity against diphtheria and tetanus, but also in curing animals affected by these diseases. The most remarkable part of their discovery is the fact that the blood of an animal that has been made immune

* Centralbl. f. Bakteriol. u. Parasitenk., vii. (1890) pp. 753–66.
† Proc. Roy. Soc. Lond., xlix. (1891) pp. 66–73.
‡ Nature, xliii. (1890) pp. 121–3.

against diphtheria or tetanus possesses the extraordinary power of destroying the poison caused by the microbe of this disease. As this power is also possessed by the serum of such an immune animal, the serum can be used as a curative means on other animals that are suffering from the disease.

After reviewing the work lately done by various investigators into immunity, Mr. Hankin tells us that the essential new proposition is this:—"The immunity of rabbits and mice against tetanus depends on the power possessed by the fluid part of their blood of rendering harmless the poisonous substances produced by the tetanus bacilli." This is a completely new theory of the nature of immunity; for, hitherto, it has been supposed that immunity must depend either on the voracious activity of the phagocytes, or on a bacteria-killing power possessed by the blood, or on an acquired tolerance against the poison.

The authors' experiments show that the blood of rabbits which have been made immune against tetanus can destroy the tetanus poison; this character is possessed by the blood both before and after it has left the vessels, and by the cell-free blood-serum obtained from it. This character is so permanent that it is still manifested by such serum after it has been injected into other animals. Various experiments are described which support these statements.

Bacillus developing a Green Pigment.*—Herren F. Winkler and H. von Schrötter isolated from the excrement of the caterpillar infesting an apple (*Carpocapsa pomonella* L.) a bacillus from 2–2·5 μ long, easily stainable with anilin dyes, and which, when cultivated on gelatin plates, liquefies the medium, causing the development of a greenish-yellow colour and a peculiar smell. In test-tube cultivations these characteristics are more pronounced, especially the liquefaction and the pigment production.

The pigment is very soluble in water, but insoluble in alcohol and chloroform. It is destroyed by acid, and restored by the application of alkalies. When cultivated on plover's-egg albumen, it developes with the production of a fine emerald green colour, while the liquefaction is delayed. On potato there was formed a reddish-yellow greasy-looking overlay, the result of confluence of the colonies.

The pathogenic effect of this bacillus was tried on rabbits, some being injected in the vena jugularis externa and others in the peritoneal sac. The former were unaffected, while the latter succumbed from peritonitis and gangrene of the intestine.

The authors propose to call this micro-organism *Bacillus melochloros*.

Bacillus producing an Indigo-blue Pigment.†—Herr H. Claessen found in Spree water a chromogenous micro-organism, the rod-elements of which corresponded approximately in length and breadth with those of *B. typh. abdominalis*. These rodlets were usually separate, but sometimes two or three were found together, and occasionally groups united by a cement. The outline of the rodlets was clearer than the centre of the bacilli, which by staining showed that they were enveloped

* Mittheil. aus d. Embryol. Institute d. K. K. Universität Wien, 1890, pp. 60–5.

† Centralbl. f. Bakteriol. u. Parasitenk., vii. (1890) pp. 13–17. Cf. Bot. Centralbl., xlii. (1890) p. 146.

in a delicate sheath. Cultivated on gelatin at 15° C. they form white colonies for the first three days, but on the fourth a blue pigment appears at the margin of deep-lying colonies, and at the edge of the superficial ones. The pigment, which is in very fine granules, does not penetrate the gelatin. The bacillus is aerobic and does not liquefy gelatin. When cultivated in meat-broth it did not thrive, and no pigment was formed, and incubation temperatures either diminished or prevented growth.

On agar there developes an indigo-blue deposit, which appears as a coloured band from 2–3 mm. wide around the edge, and resembling the iridescent shimmer of a saturated solution of gentian-violet. Potato cultivations have the same appearance as those on agar, but the pigment only appears with an acid reaction of the potato. If this be alkaline there developes only a dirty green tuft, but without any detectable morphological difference of the bacilli.

Neither spore-formation nor filamentous outgrowths were observed.

When distilled water was inoculated with bacillous material, a distinct milky clouding was observable in twenty-four hours, and a dark-blue, almost black, granular sediment was formed on the bottom of the vessel. The indigo-blue pigment was formed in the various media even in the dark.

The pigment is insoluble in hot and cold water, absolute alcohol, and in a mixture of equal parts of ether and alcohol, is slightly soluble in caustic potash, in hot sulphuric acid, and in cold hydrochloric acid.

Peculiar Disease of Bread.*—In the interior of loaves of Graham bread, one or more patches of variable size, forming brownish, sticky, viscid masses with a peculiar smell, are sometimes found. This degeneration has been found by Herren Kratschmer and Niemilowicz to be due to the action of *Bacillus mesentericus vulgatus*, which, when inoculated on healthy bread, infects it as soon as it shows a slightly alkaline reaction.

It is therefore inadvisable to bake large loaves, as the interior of the loaves is not sufficiently heated to kill the germs.

Growth of Bacillus of Symptomatic Anthrax on solid nutrient media.†—Mr. S. Kitasato has obtained anaerobic cultivations of "Rauschbrand" bacillus on agar and gelatin to which sugar, glycerin, and reducing media had been added. In solid media the bacilli retained their virulence, which was not the case in cultivations of guinea-pig broth. The most favourable temperature was from 36°–38°. Grown in gelatin under hydrogen, spheroidal colonies are formed which liquefy their adjacent medium. The bacilli are straight rods with rounded ends and possessing characteristic movements. In gelatin at the ordinary temperature they form spores only slowly, but quite quickly at incubation temperatures. The spores are oval, and the sporogenous bacilli are immobile. The spores are resistant to drying for several months; heating to 80° for one hour does not kill them.

Contrary to the statement of Metschnikoff, the author finds that

* Wiener Klin. Wochenschr., 1890, No. 30. See Bot. Centralbl., xliii. (1890) pp. 401–2.

† Zeitschr. f. Hygiene, viii. p. 55. See Centralbl. f. Bakteriol. u. Parasitenk., viii. (1890) pp. 15–6.

this bacillus does not form spores in the living body, true spores being produced 24–48 hours after death. The corpuscles which have been mistaken for spores do not possess the morphological, the biological, nor the tinctorial characters of resting forms.

The author also disputes the assertion of Roux that guinea-pigs inoculated with "Rauschbrand" are protected from malignant œdema.

Studies on Immunity.*—In a second memoir, E. Metschnikoff again takes up his parable on immunity, this time taking as his text anthrax in pigeons, and preaches against Baumgarten and others, who see in this affection objections to the doctrine of phagocytosis.

While admitting that pigeons when infected in the usual manner are very insusceptible to anthrax, the author states that this is not the case if the inoculation be made in the anterior chamber of the eye or if the anthrax have already passed through a previous pigeon; and it was further found that such virus was more dangerous to mammalia than that which had not been passed through a series of pigeons.

The author also found that the aqueous humour could by itself be used as a nutrient medium for anthrax bacilli, the spores of which, when injected into the anterior chamber, developed; their appearance being followed by the immigration of leucocytes and the simultaneous disappearance of the bacilli. Similar observations were made after subcutaneous or intramuscular inoculation; the conclusion being that the bacilli were devoured by the microcytes and macrocytes. The fate of the bacilli within the pigeons was followed out by making plate-cultivations from the exudation at the inoculation place. As a rule they were found to be still alive after twenty-four hours; in one case they were living after six days, but usually they died much earlier. They retained their virulence as well as their viability, and only occasional involution forms were found. In order to show that the bacteria were swallowed alive, some of the phagocytophorous exudate was mixed with a drop of bouillon. By this the phagocyte is killed, and the bacteria set free were observed developing under the Microscope. Besides this the author further showed that the bacteria which had been swallowed retained their virulence. This was done by isolating three phagocytes which contained bacteria by means of a fine glass pipette and transferring them to bouillon. Positive results were obtained with mice, guinea-pigs, and rabbits.

In a further communication on the relations between anthrax and white rats, the author shows that these animals do not possess perfect immunity to anthrax. The bacilli always develope, although usually the inoculation is followed by recovery, in which the phagocytes play an important part.

Mucous Fermentation.†—Herr E. Kramer finds that the process of mucous fermentation, which may happen to various substances, is excited by at least three species of bacteria, the nature and the reaction of the

* Annal. de l'Institut Pasteur, 1890, pp. 65 and 193. Cf. Centralbl. f. Bakteriol. u. Parasitenk., vii. (1890) pp. 545–7; viii. (1890) pp. 58–9.

† SB. K. K. Akad. Wiss. Wien, x. (1889) pp. 467–505. See Bot. Centralbl., xliii. (1890) p. 298.

fluid being of importance to the result. Fluids containing glucose with neutral or slightly alkaline reaction are decomposed by *Bacillus viscosus sacchari*. This is 1 μ thick, 2·5 to 4 μ long, motionless, forming filaments, liquefying gelatin, and being aerobic. Acid glucose solutions become mucous from the action of *B. viscosus vini*. This bacillus is 2–6 μ long, 0·6–0·8 μ thick, is anaerobic, and grows only in acid solutions. Solutions containing milk-sugar become mucous from the action of a coccus 1 μ in diameter. The mucus is a carbohydrate having the formula $C_6H_{10}O_5$, and is apparently derived from the external membrane.

Bacteria in Water.*—Dr. W. Migula, who has examined 400 different kinds of water taken from Silesia and Baden during the years 1888 and 1889, lays it down as an axiom that the harmfulness of water depends rather on its impregnation with different kinds of bacteria than upon the number of colonies. Hence a bacteriological examination of drinking water should be directed towards enumerating the different kinds of micro-organisms, instead of merely counting up the absolute number of colonies present in a cubic centimetre of water. In his article he gives five different tables, the results of which may be summed up as follows:—

(1) The results obtained from counting the colonies of bacteria in 1 ccm. of water are no criterion of its value as a drinking water. (2) Putrefaction bacteria are almost completely absent from drinking water. (3) Putrefaction bacteria are most frequent when water contains 1000–10,000 germs to 1 ccm., but are still present when it contains less than 50 germs, but if there be more than 10,000 germs they are not so numerous. (4) Putrefaction bacteria attain their greatest frequency when the number of different species present in water is greatest. (5) The relation between the number of kinds and the number of colonies is very indefinite.

Bacteria of Chemnitz Potable Water.†—Herr O. E. R. Zimmermann describes the following new species found in the Chemnitz water supply:—*Bacillus fluorescens aureus*, *B. fluorescens tenuis*, *B. fluorescens albus*, *B. fluorescens longus*, *B. rubefaciens*, *B. implexus*, *B. punctatus*, *B. vermiculosus*, *B. constrictus*, *B. fulvus*, *B. miniaceus*, *B. devorans*, *B. gracilis*, *B. helvolus*, *B. plicatus*, *B. guttatus*, *B. radiatus*, *B ochraceus*, *B. subflavus*, *Micrococcus rosettaceus*, *M. cremoides*, *M. carneus*, *M. sulphureus*, *M. concentricus*. Taken all together, 40 species of bacteria are enumerated, and their specific differences described.

Chemical Products of Growth of Bacillus anthracis.‡—Dr. S. Martin grew bacilli in a solution of pure alkali-albumin and of mineral salts of the composition of the salts of the serum. The anthrax bacillus, in digesting the alkali-albumin, forms proto-albumose, deutero-albumose, and an alkaloid. The alkalinity of the albumoses may explain their toxic properties; the bacillus forms the alkaloid from the albumose, and it is possible that the living tissues have a similar action when the albumose is introduced into a living animal.

* Centralbl. f. Bakteriol. u. Parasitenk., viii. (1890) pp. 353-61.

† 11 Bericht d. Naturwiss. Gesell. zu Chemnitz, 1890. See Bot. Centralbl, xliii. (1890) p. 272.

‡ Proc. Roy. Soc. Lond., xlviii. (1890) pp. 78–80.

fluence of Physical Conditions on the Life of Micro-organisms.*—Drs. E. Bonardi and G. G. Gerosa have made a series of experiments on the susceptibility of micro-organisms to environmental influence. They start with a useful summary of the results already reached by others, and then expound their own. In solutions of flesh-extract and peptone the density of the fluid has no effect on form; in gelatin the microspores are found only in the denser solutions; in flesh-extract the multiplication is more abundant and rapid in the less dense solutions, in gelatin the reverse is true; in flesh-extract of whatever density only Schizomycetes develope, in gelatin *Penicillium* predominates, in peptones both occur equally. The minimum temperature at which microbes will develope varies with the quality and density of the organic solution; in flesh-extract of slight density they multiplied for eleven days at 5°, but when the density was increased the temperature had to be raised to 10°, while in gelatin they remained sterile for months at 25°. A solution of flesh-extract of slight density was sterilized at 50°, but a denser solution required 60°. After three days at 79°, granulations appear which are not absolutely distinguishable from the indubitable organisms. In all the solutions, *Bacillus subtilis* prevails at higher temperatures above 30°, *B termo* at lower, but both show themselves in manifold instable forms. In favourable solutions of flesh and peptone, *B. subtilis* resisted for twenty-four hours temperatures of 79° and even 100°. Heating flesh-extract for two or three hours in a Papin's stove at 120°-130° did not hinder the appearance of spherical organized bodies. Carbonic acid gas and nitrogen only retard development, magnetic and electric influences have likewise a retarding influence, and this is very markedly the case with sunlight.

Red Nitro-indol Reaction as a Test for Cholera Bacilli.†—Herr R. J. Petri considers that the red nitro-indol reaction is of diagnostic value for ascertaining the presence of cholera bacteria. It would appear, however, from his experiments that this value is rather scientific than practical, inasmuch as the test must be used in combination with plate-cultivations and other suitable methods for recognizing the micro-organisms, and also that it is essential that pure cultivations only should be employed, contents of the intestinal canal and the like being unsuitable.

The reaction in question is the production of a red colour in the cholera vibrio after the addition of sulphuric acid; a reaction which results in the formation of indol and nitrite. The author confirms the original observation that the reaction takes place on media containing pepton. After the addition of the acid, 10 drops to 6 ccm. of the nutrient medium, the red reaction begins to appear after four hours' incubation, attaining its maximum in twenty-four to forty-eight hours, after which it dies away.

A similar red colour was obtained by the reagents used with other bacteria, a fact which, as alluded to above, seems to deprive this test of much of its so-called value.

Tumours in Animals.‡—M. A. F. Plieque, in discussing the ætiology of tumours, lays it down that it is of great importance to

* Atti R. Accad. Lincei—Mem., v. (1888) pp. 332-73.

† Arbeiten a. d. Kais. Ges.-Amte, vi. p. 1. See Centralbl. f. Bakteriol. u. Parasitenk., viii. (1890) pp. 152-3.

‡ Rev. de Chirurgie, ii. (1890) No. 7. See Centralbl. f. Bakteriol. u. Parasitenk., viii. (1890) pp. 148-9.

ascertain if these be of parasitic origin. Actinomycosis may be safely quoted as an instance of parasitic disease, while a similar origin for other tumours, such as melanosis in horses, may be more than suspected. After alluding to the transmissibility of actinomycosis from man to animals and *vice versâ*, the method of infection, the immunity of Carnivora, the author turns to other tumours, the existence of which depends on the immigration of micro-organisms.

Botryomyces and *Discomyces*, two fungi closely allied to *Actinomyces*, are found in those large fungous tumours which frequently develope in horses after gelding. In the numerous small abscesses which appear in the new growth are found bright points resembling the grains of *Actinomyces*, only somewhat smaller.

To melanosis, a common disease of horses, the author attributes a parasitic origin, the black granules besetting the tumour probably containing the parasite, which is, perhaps, a protozoon. Cultivations made with the granules have, however, hitherto failed. A parasitic origin is also claimed by Dominic for the papillomata of oxen (*Bacterium porri*), by Czokor for *Epithelioma contagiosum* of birds (a Gregarinid), and by Perroncito for the cyst-formations on the mesentery and pleura of birds (*Aspergillus nigrescens*).

Frequently too the tumours of plants have a parasitic origin; such tumours may be induced by infusoria (on the roots of Leguminosæ), by bacteria (tumours on fir and olive trees), and by higher fungi (the tumours on maize). The *Plasmodiophora brassicæ*, the cause of the tumours on cabbages, may belong to the group of Actinomyces fungi.

Although the parasitic theory of tumour formation is very seductive, the author cautions against general conclusions, on the ground that the vast majority of inoculation and transplantation experiments have been negative. The ill success of these experiments is declared by the author to be due to the neglect of certain important factors influencing tumour formation, in the choice of the inoculated animals. For example, no account is taken of age, an important factor in tumour formation, nor of the kind of animal to be inoculated, those usually operated on being rabbits and guinea-pigs, animals little prone to be affected by tumours; nor of the tissue to be selected for the experiment, that usually chosen being the subcutaneous tissue, a part in which tumours rarely develope spontaneously. Better results would possibly be obtained by attending to such conditions.

Osteomyelitis and Streptococci.*—MM. Lannelongue and Achard find from experiments that pyogenic Streptococci can produce in bone-marrow changes similar to those brought about by Staphylococci. The osteomyelitis induced by Streptococci is rarer than that caused by Staphylococci.

Microbes of Acute Infectious Osteomyelitis.†—MM. Courmont and Jaboulay find from intravenous injection of rabbits that suppuration of bone can be induced by several kinds of micro-organisms. The osseous

* CR. Soc. Biologie, 1890, No. 19. See Centralbl. f. Bakteriol. u. Parasitenk., viii. (1890) p. 731.

† CR. Soc. Biologie, 1890, No. 18. See Centralbl. f. Bakteriol. u. Parasitenk., viii. (1890) p. 731.

tissue is directly affected by Staphylococci, while the bone-marrow is principally affected by Streptococci.

Controversy on Phagocytosis.*—One of the last passages at arms between the supporters and opponents of the theory of phagocytosis as it is called by the inventor, Metschnikoff, is that of Hueppe and Petruschky. The former opines that natural immunity is closely connected with the cell-element of the body, although the extra-cellular influence possibly possesses some protective effect. Petruschky, however, points to the experiments of Nuttall, Buchner, himself, and many others, as showing that immunity is the result of biochemical processes going on in the body. And he even denies the efficacy of any co-operative assistance afforded by the phagocytes. To this Hueppe replies that no doubt the body juices do exert some chemical action on bacteria; but that this action is insufficient to explain the different behaviour of different species of animals towards bacteria, and that therefore cell action must be admitted to possess an important influence, and he further emphasizes his position by reasserting that there is no doubt that phagocytes do pick up living and virulent bacteria, and that recent biochemical researches teach us anew that we are led astray by chemical theory if we lose sight of the cell.

In response to this, Petruschky addresses himself merely to the particular point about the vitality of the bacteria when picked up by the leucocytes. Living anthrax bacilli, he says, are endowed with a kind of stickiness, which causes them to adhere to the corpuscle. Of course, the chief argument against the theory of phagocytosis is that bacteria are disposed of by blood-serum, both under artificial and natural conditions.

Bacteria in Wort and in Beer.†—Herr A. Zeidler examined three kinds of bacteria occurring in wort and in beer. One of these presented some resemblance to *Bacterium termo*, but formed also chains and filaments. The wort had a celery-like odour. The two other sorts set up acetous fermentation; one of them was identical with *B. aceti*, while the third did not agree with the descriptions of *B. aceti pasteurianum* or *xylinum*.

Pure cultivations of these bacteria were inoculated on sterilized wort, wort in various stages of alcoholic fermentation, and on compressed pure cultivations of yeast. It was found that the termo-like bacterium died as soon as the alcoholic fermentation set in, and when cultivated on the compressed yeast the latter was rapidly decomposed.

One of the acetic acid bacteria, especially at certain temperatures, set up a mucoid change in the beer, but the other had no such effect.

Günther's Bacteriology.‡—The recently published manual of Dr. C. Günther chiefly appeals to students of medicine, offering to them, in a compact form, the science and practice of Bacteriology, and specially

* Fortschritte d. Medicin, viii. (1890) Nos. 12, 13, and 15. See Centralbl. f. Bakteriol. u. Parasitenk., ix. (1891) pp. 29–31.

† Wochenschrift f. Brauerei, 1890, Nos. 47, 48. See Centralbl. f. Bakteriol. u. Parasitenk., ix. (1891) pp. 10–11.

‡ Leipzig, 1890, 244 pp. See Centralbl. f. Bakteriol. u. Parasitenk., ix. (1891) pp. 11–12.

dealing with the technique required for the microscopical examination of micro-organisms.

In the general portion of the work the author treats of the morphology, biology, and classification of bacteria, and then describes the means for their prevention, their observation, and their cultivation.

In the special part are discussed the most important of the pathogenic bacteria, and also a certain number of saprophytic organisms.

Bacteriology for Farmers.*—The object of this work, written by Dr. W. Migula, is to disseminate the results of bacteriological investigations in so far as they may have practical bearings, and consequently it does not present any novel features. It is apparently chiefly intended for persons engaged in agricultural pursuits, and to these at any rate it may be recommended.

DAVID, TH.—**Les microbes de la bouche.** (The Microbes of the Mouth.) Paris, 1890, 8vo, 113 figs.

DESPEIGNES, V.—**Etude expérimentale sur les microbes des eaux.** (Experimental Study on the Microbes of Water.) Paris, 1891, 8vo.

KECK, E.—**Ueber das Verhalten der Bakterien im Grundwasser Dorpats, nebst Beschreibung von 10 am häufigsten in demselben vorkommenden Bakterienarten.** (On the Bacteria in the ground-water of Dorpat, with description of ten of the commonest species found therein.) Dorpat, 1890, large 8vo, 66 pp.

LEWANDOWSKI, A.—**Ueber Indol und Phenolbildung durch Bakterien.** (On the Formation of Indol and Phenol by Bacteria.) *Deutsche Med. Wochenschr.*, 1890, No. 51, p. 1186.

NUTTALL, G. H. F.—**Beiträge zur Kenntniss der Immunität.** (Contributions to our knowledge of Immunity.) Göttingen, 1891, large 8vo, 55 pp.

POTTER, T.—**Some of the Problems of Bacteriology.** *Indiana Med. Journ.*, 1890–1, pp. 28–30.

PRUDDEN, T. M.—**Bacillus versicolor.** *Proc. New York Pathol. Soc.* (1889) 1890, p. 103.

RUBNER.—**Beiträge zur Lehre von den Wasserbakterien.** (On Water-Bacteria.) *Arch. f. Hygiene*, XI. (1890) Heft 4, pp. 365–95.

SMITH, T.—**Observations on the Variability of Disease Germs.** *New York Med. Journ.*, II. (1890) No. 18, pp. 485–7.

TILS, J.—**Bakteriologische Untersuchung der Freiburger Leitungswässer.** (Bacteriological Examination of the Water of Freiburg.) *Zeitschr. f. Hygiene*, IX. (1890) Heft 2, pp. 282–322.

TURINA, V. A.—**Ricerche sui germi dall'aria e della polvere degli ambienti abitati.** (Researches on the Germs of the Air and Dust of Inhabited Regions.) *Giorn. d. Reale Soc. Ital. d'Igiene*, 1890, Nos. 8–10, pp. 452–66.

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* Berlin, 1890, 8vo, 144 pp. See Centralbl. f. Bakteriol. u. Parasitenk., viii. (1890) p. 361.

MICROSCOPY.

a. Instruments, Accessories, &c.*

(2) Eye-pieces and Objectives.

"On a new System of Erecting and Long Focus Objectives."† — M. L. Malassez, after referring to the advantage of erect images and long focal lengths, when delicate dissections have to be made, exact measurements determined, &c., writes:—

"For these purposes we have already at our disposal the simple lens or the doublet, the Brücke lens, and the ordinary compound Microscope furnished with erecting apparatus. These instruments are excellent in certain cases, but are certainly unsatisfactory in many others. Thus, the simple lens and the doublet do not give sufficiently strong magnifications with foci sufficiently long, and, in making use of them, it is necessary to bend over the object to be examined in a very uncomfortable way. The Brücke lens possesses the advantage of having a very long focus, but the magnification which it affords is not very considerable. The Microscope itself gives all the magnification desired, but as soon as this becomes at all considerable, the focus is very short, and there is no room for manipulation.

I have devised a new system of objectives, which gives the best results. Adapted to the ordinary Microscope, the objective gives at once, without erecting apparatus, an erect image of the object examined. Its focus is very long, as long as could be wished. One of them has a focus of 7 cm., while it gives a true magnification of 30 diameters with a No. 2 eye-piece of Vérick, and a tube-length of 16 cm. I have made some which had foci much longer, reckoned by metres instead of centimetres. With these it was possible to see with the Microscope objects placed at the other end of the work-room, or even objects more distant still, such as houses and monuments at a distance from the window. However, as we lose in magnification and light what we gain in length of focus, it is of advantage to limit this as much as possible.

These new objectives possess the further advantage of considerable penetrating power, i. e. it is possible to vary the focus without losing the object. The one mentioned above has, for instance, a penetration of 2 to 3 millimetres. It is possible to get more, but it is necessary to limit it, for it would be at the expense of the defining power, i. e. at the expense of the clearness of the images.

The field of view is sufficiently large; that of the objective already taken as an example is from 8–10 mm. in diameter. With it microscopic images are obtained perfectly plane. The field is, of course, enlarged as the magnification is reduced. The device by which I have obtained the two principal properties characteristic of this new system of objectives, viz. the erection of the images and the indefinite length of the foci, is as follows:—

The different lenses composing the objectives really form two distinct

* This subdivision contains (1) Stands; (2) Eye-pieces and Objectives; (3) Illuminating and other Apparatus; (4) Photomicrography; (5) Microscopical Optics and Manipulation; (6) Miscellaneous.

† Arch. de Med. Expér., i. (1889) pp. 449-54.

optical systems, each acting as a single convergent lens. One, called for convenience of description the first lens, occupies the lower part of the objective next the object to be examined; while the other, called the second lens, occupies the upper part in connection with the Microscope-tube.

Matters are so disposed that the first lens gives behind it and in front of the second an inverted image of the object, and the second then gives behind it an inverted image of this first. It follows from this that this second image, inverted in relation to the first, is really erect in respect to the object. As this is the image examined by the eye-piece which does not invert, it accordingly remains erect with respect to the object. In other words, the aim of the first lens is to give an inverted image of the object; while the second acts as an ordinary objective, and with the eye-piece constitutes a compound Microscope; so that we examine with this Microscope, not the object itself, but an inverted image of it produced by a lens placed in front of the objective, between it and the object. The Microscope, as it inverts anew this inverted image, gives a final image, which is erect with respect to the object examined.

The possibility of obtaining with these new objectives very long foci, and of any length desired, is explained very easily. With convergent lenses, the farther the object seen, the nearer to the principal focus is the image on the other side of the lens; so that if it is wished to receive it on a screen or examine it with an optical apparatus, it is necessary to approach the nearer to the principal focus. Reciprocally, when very near the lens, it is only possible to see the images of very distant objects; and, on the other hand, when receding from it, only those of objects very near. Similarly, with this new system of objectives, if the second lens is brought near the first, only very distant objects can be seen, and accordingly the focal length of the whole system will be augmented; while by separating the lenses the focal length will be diminished, and only nearer objects can be seen. I have made one of these objectives in which the two lenses can be approached or separated at will, so as to vary at pleasure the length of the foci, and to see with the Microscope objects more or less distant. In practice, however, I think that it is better to use objectives with fixed focus.

The idea of erecting microscopic images by means of the objective is not new. Strauss-Durkheim says, in his treatise on Comparative Anatomy (I. p. 81), published in 1842, that he succeeded twenty-five years previously in erecting the images of compound Microscopes by placing an additional objective below the ordinary objective, and he describes and figures the arrangement which he adopted. He would seem to have shown this improvement to Trécourt and Oberhauser, and it was probably their Microscope thus modified which they presented in 1839 to the Academy of Sciences (ix. p. 322, "Microscope achromatique à tous grossissements"). It gave very variable magnifications, had foci greater as the magnification was weaker, and gave erect images. Fischer de Waldheim, of Moscow, had the same idea about the same time, and constructed a Microscope to which he gave the name of pancratic.

These Microscopes did not appear to have any success. Robin, in his 'Traité du Microscope' (1871, p. 162), states that their images were

wanting in clearness, and that for a long time he had given up their use "pour quelque genre de travail que ce soit." Now they are forgotten, very few treatises on the Microscope mention them, nor are they referred to in catalogues of makers.

In my preliminary trials I contented myself with adding an objective to the existing one, thus making unconsciously a pancratic Microscope. But although by this arrangement very curious optical effects could be obtained, it was not advantageous for the special end in view, viz. convenience of manipulation under the Microscope; for that purpose what could be the use of these foci of indefinite length, or these high magnifications which are only obtained by reducing the working distance and losing light? I then conceived the idea of replacing the single lens system, giving by simple changes of position all kinds of foci and magnification by a series of special systems, each composed of fixed lenses, and consequently giving a definite focal length and magnification, each system being specially combined in order to produce a definite optical effect, and presumably giving more perfect results. Thence followed the erecting objectives of long focal length described above. If the principle on which they depend is already known, they may at least be considered as a new and more practical application.

The first of these new objectives was constructed by me eleven years ago, and was shown then to many persons, amongst whom was M. Vérick, who undertook to make similar ones. He did not do so, but his successor has been engaged under my direction in this new work. Any maker will be able easily to do the same after some trials."

The New Apochromatic Objective.*—Dr. J. D. Cox writes:—"In the February number of the Royal Microscopical Society's Journal we find a synopsis of work done with the new apochromatic objective of 1·63 N.A. by Dr. Van Heurck, the distinguished director of the Antwerp Botanical Garden. Some references to the same appear in a late bulletin of the Belgian Microscopical Society. The results mark a positive advance in the perfection of objectives, though, as Prof. Abbe warned us when announcing the apochromatic lenses which the new Jena glass made possible, each step must be a small one in the present state of the art, and there are apparently but few more within the range of the knowledge and the means possessed by us.

Now, as heretofore, the study of the diatoms gives the means of testing the progress in lens making, and gives the chief stimulus to scientific opticians. Dr. Abbe, who has become personally interested in the Zeiss optical establishment at Jena, is uniting all the resources of scientific formulæ with the skill of an almost perfect mechanical *atelier* to produce wider angled objectives; whilst Dr. Van Heurck, stepping into the place so long occupied in the microscopical world by our lamented Dr. Woodward, of the Army Medical Museum, is, with his dark-room and heliostat, demonstrating what the new lenses will do upon the old familiar tests of *Pleurosigma angulatum*, the small *Navicula rhomboides* (*Frustulia saxonica*), and *Amphipleura pellucida*. When, under his skilful manipulation, real progress is recorded, the improved lens quickly finds its way into the hands of the enthusiasts of the school

* Microscope, x. (1890) pp. 164-8.

of Koch in the rival department of investigation of the infinitely little, to determine what it can tell us in regard to the structure and growth of bacteria.

The photographs which illustrate Dr. Van Heurck's latest work with the new lens seem to show two things: first, that he exhibits the areolation on the valve of *Amphipleura* with a distinctness of definite resolution beyond anything heretofore published; second, that in regard to the less finely marked shells, no perceptible advance upon work done with glasses of narrower angle is apparent. A word further as to each of these points.

In the resolution of *Amphipleura*, as in regard to other tests, there has been a regular progress, partly dependent on real improvement in lenses, and partly upon the use of better methods of manipulation. The mounting of the specimen has also been an element of no small importance. Everybody knows that a diatom mounted dry is much more boldly visible than one mounted in balsam. Striæ are shown, in this case, with much less oblique light, and may be resolved by a glass which quite breaks down when used on the balsam mounted specimen. This is consistent with the fundamental principle that the angle of aperture of a lens determines the possibilities of its work in the resolution of fine details in all microscopic objects. A well corrected glass will do more than a badly corrected one made on the same formula and with the same aperture. No glass of high power has ever been made so perfect as to perform all the theoretic possibilities for a glass of its angle. But however well made the lens may be, it is a mere waste of time and eye-sight to try to make it show details too fine for the theoretic capability of its angle of aperture.

The average fineness of striation of *Amphipleura pellucida* is for the transverse lines about 90,000 to the inch, and of the longitudinal (by Dr. Van Heurck's measurement) about 125,000. But the finest of these are (by the R. M. S. tables) theoretically resolvable in photography by a dry glass of 180° aperture, by a water-immersion glass of 100° water angle, or by a homogeneous immersion glass of 83° balsam angle, all being of a numerical aperture 1, substantially. It thus appears that the angle of 1·63 N.A. is ·63 in excess of what is theoretically required to do the work which Dr. Van Heurck has accomplished with it, or, in other words, that our high power glasses do less than two-thirds of what perfect glasses of their aperture might do, if the tables are correct. Here, then, is a large margin for the improvement of the whole series of immersion lenses, since almost any lenses of first class makers found in the market, have angle enough, in the high powers, to do all that the new apochromatic has done.

But before we can decide how far the new lens is superior to older ones of less aperture, we must have the latter tested under equal conditions, and it is to be hoped that Dr. Van Heurck will add this to his useful labours. The new photographs are from objects mounted in a medium of refractive index 2·4, with both slide and cover-glass closely approximating the same index. They are also taken with monochromatic sunlight. Ever since Prof. H. L. Smith introduced the highly refractive media, it has been well known to microscopists that a very thin and finely areolated shell like *Amphipleura pellucida* is so much

more easily resolved in them that the test when so mounted loses very much of its difficulty. If we make the slide and cover-glass nearly or quite homogeneous with the medium, and in addition to this increase considerably the aperture of the substage condenser, and connect it with the slide by a highly refractive immersion medium, it needs no telling that the difficulties of resolution have been still further and very greatly diminished. Prof. Abbe and Dr. Van Heurck deserve great praise for devising and putting to use the means of effecting such favourable conditions; but the difference between these and the conditions under which other glasses are used must be eliminated before we can tell how much of the improvement in work is due to the lens, and how much to the conditions.

In regard to my second point, viz. that as to the less finely marked shells, no perceptible advance in the character of work is apparent, I will only say that Dr. Woodward's photographs, exhibited at the Centennial Exposition at Philadelphia in 1876, must remain the standard of comparison when the work of the older lenses is brought into question. He worked with a Powell and Lealand water-immersion of 1/16 in. of 1869, and Tolles's 1/10 and 1/18 of similar construction. A little later he used also Spencer's glycerin immersion 1/6 and 1/10, Zeiss's homogeneous immersion 1/8 and 1/12, and a homogeneous 1/10 by Tolles. I think none of these glasses had an aperture greater than 1·25 N.A. Whilst writing this paper I have examined those photographs afresh, and am entirely sure that for the exhibition of the areolation and structure of *Navicula rhomboides*, both the coarser and finer forms (including *Frustulia saxonica* or *Navicula crassinervis*) *Surirella gemma*, *Amphipleura Lindheimerii*, *Pleurosigma angulatum*, and for the transverse striation of *Amphipleura pellucida*, they are fully equal to anything that has been done with the most recent and widest angled glasses, not merely as photographs, but as conclusive evidence of the quality of the glasses he used and their satisfactory work within the limits named.

Dr. Van Heurck has taken one step in advance (and it is a real one), which shows with what labour each step is now gained. The new glass has cost Prof. Abbe months of labour, as is reported; and no inconsiderable expense in money, as well as time, has been lavished upon it. The result, to put it in its most general form, is that where we could distinguish objects in the approximate form of circles or squares of a diameter of 1/100,000 in., we may now (under exceptional conditions) distinguish them if 125,000 to the inch. Yet this may make the difference between tracing definitely some part of the life-history of a bacillus or failing to trace it.

The apochromatic system is by no means synonymous with increase of angular aperture, though it adapts itself readily to the widening of angles. It is distinctively a step in the reduction of the conflict between the chromatic and spherical corrections, by the aid of the wider range in refraction and dispersion which the newly-invented Jena glass possesses. It is therefore directly aimed at the problem stated before, viz. the bringing of the practical performance of our lenses more nearly to the standard of their theoretic possibilities. The effort to do this by using material of higher refractive index for lenses is an old one. Even diamonds have been used for experiment in this direction. The solution

of the problem has been sought also in the identical direction in which Dr. Abbe is working. More than a dozen years ago Charles A. Spencer told me of his own efforts, in the earlier part of his life, to manufacture new varieties of glass with the qualities now found in the Jena glass, but abandoned it because his pecuniary means were wholly inadequate to that sort of experiment. The liberality of the German Government, backing up the combination of high scientific acquirements of Dr. Abbe and his associates in the directions of physics and chemistry, has produced the valuable results we see. A single consideration still holds back many investigators on this side the ocean from giving implicit faith to the new system, and that is the fear as to the durability and chemical stability of the new glass. There is, whether rightly or not, a strong impression that a too large proportion of the apochromatic lenses have been short lived, and some of the failures have been in the hands of such careful and skilful manipulators that careless handling cannot be assumed. To have a costly lens fail on one's hands when the maker, who alone can be properly trusted to repair it, is on the other side of the globe, and custom house regulations are a practical veto on sending it back and forth, makes an earnest student of Nature pause. The same doubt seems to make American opticians cautious in using the new material, and it is hardly to be regretted that they should first exhaust the means of perfecting objectives made of the "old reliable" flint and crown glass. In the hands of the average manipulator the new lenses do not show superiority over high-class American ones. The art of manipulating them (for it is an art) may well occupy some of the hours of the student, with the assurance that till he has acquired some skill in that way, he will not be able to detect the difference between tools having so nice shades of merit. And even then he may console himself that many experts agree with the opinion of Dr. Detmers, that, angle for angle, it cannot yet be said that the best European lenses excel the best American."

Ancient Lenses.*—Mr. Henry G. Hanks calls attention to a very old reference to lenses, or magnifying glasses, which he recently found in an old work, 'The Vanity of Arts and Sciences,' by Henry Cornelius Agrippa. The edition shown was an English translation, published in 1676, from the original Latin edition, published in 1527. The reference alluded to reads thus:—

"So we read, as Celius in his ancient writings relates, that one Hostius, a person of an obscene life, made a sort of glasses, that made the object seem greater than it was, so that one finger should seem to exceed the whole arm, both in bigness and thickness."

It was found that Cælius Antipater (to whom Agrippa probably refers) was a Roman historian who lived 125 years B.C. He wrote a history of the first Punic War, only parts of which were extant. So far as known, this was the first account of magnifying glasses in history. Henry Cornelius Agrippa, the author of this curious old book, was born at Cologne in 1486, and was a man of talents, learning, and eccentricity. In his youth he was secretary to the Emperor Maximilian, and was knighted for bravery in Italy. On quitting the army he devoted himself

* Amer. Mon. Micr. Journ., xi. (1890) p. 243.

to science, and made pretensions to an acquaintance with magic. In 1530 he wrote his treatise 'On the Vanity of the Sciences,' which was a caustic satire upon the inefficiency of the common modes of instruction. After an active, varied, and eventful life, he died at Grenoble in 1539.

(3) Illuminating and other Apparatus.

New Measuring Apparatus for Microscopical Purposes.*—Dr. G. Lindau remarks that of all the pieces of apparatus which have been proposed for the measurement of small objects under the Microscope, the screw and glass micrometer in combination with objective or eye-piece has proved the best. Of these the eye-piece micrometer is by far the most convenient, and is to be preferred to all other micrometers, especially where a mean of several observations is taken. Cases however occur in which the eye-piece micrometer fails to be of service, as in the measurement of thin membranes or threads and in physical investigations on wave-lengths of light, &c. A micrometer constructed by Dr. V. Wellmann may replace it with advantage in these cases. It was originally intended for astronomical purposes, but forms a very useful micrometer for the Microscope. It is especially serviceable for measuring very small objects not exceeding a few μ in size. It differs in principle from all other micrometers in depending on the double refraction of light in certain crystals. It is well known that on looking at a point through a prism of rock-crystal two images, the ordinary and the extraordinary, are seen. As the prism is rotated about the optic axis, the extraordinary image rotates about the ordinary. Consequently, if such a prism is fitted over a microscopic eye-piece in whose focus a thread is stretched, two images of the thread are seen. On rotating the prism the apparent distance of these two images for a certain position becomes zero (the images coincide), and on rotating through 90° from this position it reaches a maximum. On continuing the rotation up to 180° the images again coincide. In the rotation from 180° to 360° the images behave in a similar way, except that the movable one changes over to the other side.

In the new micrometer these two images are used in precisely the same way as the threads of a screw micrometer, for by suitable rotation of the prism their distance is made equal to the image of the object to be measured. The distance of the two images is given by

$$\Delta = m \sin \phi,$$

where ϕ is the angle through which the prism is rotated, and m is the apparent maximum distance of the images for a given magnification v. This constant m is easily determined by measuring objects of known size.

Now the apparent magnitude of an object, of which the actual size d is to be determined, is given by

$$\Delta' = d \,.\, v.$$

Consequently, when by rotating the prism

$$\Delta' \text{ is made } = \Delta = m \sin \phi,$$

* Naturwissensch. Wochenschr., iv. (1889) pp. 185-6 (1 fig.)

we have

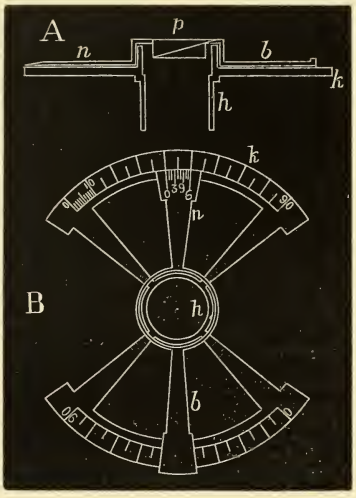
$$d = \frac{m \sin \phi}{v}.$$

To avoid calculations during the observation, Dr. Wellmann has prepared tables of the value of d for different values of ϕ and v.

$\frac{m}{v}$ is usually a very small quantity, which for the prism and lenses used by the author amounted only to 9 μ. Accordingly, to pass from 0 μ to 9 μ the prism must be turned through 90°, so that great exactness is obtained for even a comparatively rough reading. Thus a reading of 1/10 degree on the circle gives an exactness of

$$\frac{9}{90 \cdot 10} = 0 \cdot 01 \ \mu.$$

Fig. 15.



The apparatus itself, as constructed by Schmidt and Hänsch, consists of two parts (fig. 15 A and B). The divided circle k is, by means of the socket h, passed over the body-tube of the Microscope, and is fastened by three screws. Only two opposite quadrants are used, and the rest of the circle, together with the middle portion of the quadrants, is cut away to diminish the weight of the apparatus. The eye-piece is then inserted in the body-tube. Above the socket of the divided circle, which projects upwards, another is fitted which easily turns about it. This carries in its upper part the prism p of rock-crystal, with refracting angle of 70°. Beneath are two projecting arms, one of which n serves as vernier reading to 1/10 degree, and the other b to balance and turn the apparatus.

Polarizing Prisms.*—Dr. W. Grosse calls attention to the important part played by calc-spar prisms in so many physical instruments, and regrets the high price of the material and the great loss which takes place in the course of preparation of the prisms. The various forms of prism are classified as follows :—

I. Prisms in which both rays wholly or partially occupy the field of view. Besides the older well-known forms of Wollaston, Senarmont, and Rochon, there are the more recent prisms of Dove and Abbe, the latter of which consists of an equilateral prism of calc-spar, with wedges of crown glass on the sides.

II. Prisms in which the central zone of the field of view is occupied only by one ray (the extraordinary).

* Zeitschr. f. Instrumentenk., x. (1890) p. 445.

1. With one diagonal slit, and between the two faces
   a. Canada balsam or linseed oil;
   b. Air.
2. With two diagonal slits intersecting
   a. In the middle of a basal plane (Ahrens);
   b. In the middle of the prism (Bertrand).

III. Prisms which contain only the lamella of a doubly refracting medium.

The requirements of an ideal prism are:—Plane polarized field, largest possible field of view, slightest possible refraction of the ray, smallest possible ratio of length and breadth, and least possible waste of material.

In the following table the numbers 1 to 5 serve to estimate the value of the prism for the specific property indicated in each of the horizontal rows. The last column gives for each of these properties the most advantageous forms—viz. those marked with 4 or 5.

	Nicol Group.					Air Prisms.		Double Slit.		Double Slit Air Prism.	Plate Prisms.	Advantageous Form.
	Nicol.	Hartnack.	Thompson.	Dove.	Abbe.	Glan.	Foucault.	Bertrand.	Ahrens.			
1. Plane polarized field	3	4	5	2	2	2	2	2	3 (1)	2	1	Thompson, Hartnack.
2. Field of view ..	3	3	3	2	2	1	1	4	4	1	5	Plate prism, Bertrand, Ahrens.
3. Loss of light ..	4	5	5	5	3	2	2	3	5	2	1	Dove, Hartnack, Thompson, Ahrens.
4. Displacement of ray	2	5	5	5 (1)	5	3	1	3	5	3	4	Hartnack. Thompson, Abrens (Dove).
5. Ratio of length and breadth ..	1	1	1	3	3	4	4	1	3	5	2	Air-prism with double slit, Glan, Foucault.
6. Waste of material	4 (3)	2	1	4	4	2	4	3	3	4	5	Plate-prism, Dove, Abbe, air-prism.
Total.. ..	17 (16)	22	20	17(+4)	19	14	14	17	21 (+2)	17	18	

At the author's suggestion, Herr Halle, of Potsdam, has undertaken the preparation of the air-prism with double slit, referred to in the above table. It is not half so thick as broad and long, and would be useful as a polarizer. Another form suggested by the author may be described as a Bertrand prism with air slit. It is rather thicker than broad and long; but as the field of view amounts to 15° it would be very serviceable as an analyser.

A new Camera Lucida.*—Herr G. Govi describes a new camera lucida, which consists of two rectangular equal-sided prisms of the same glass, one of which is smaller than the other. The hypothenuse face of the smaller, which is coated with thin gold-leaf, must be as large as the side face of the larger, on which it is fastened with Canada balsam or some other substance with refractive index as near as possible to that of the glass.

The hypothenuse face of the larger prism is turned at 45° to the

* Central-Ztg. f. Optik u. Mechanik, x. No. 22, p. 260.

horizontal, and lies above the eye-piece of the Microscope. The eye sees from above through one side face, at the same time, the microscopic object and the paper on which the drawing is to be made. The rays proceeding from the latter fall on the other side face of the small prism, are refracted into this, and so reflected on the gold-leaf that they reach the eye in the direction of the rays coming from the Microscope.

A new Ocular Diaphragm.*—Prof. Wm. Lighton writes:—In a paper read before the American Society of Microscopists at Indianapolis in 1878, I described a new dark-field eye-piece which was the result of experiments begun in 1863, and which was also described and illustrated in the first number of the 'American Quarterly Microscopical Journal,' published in 1878 by Prof. Romyn Hitchcock.

There also appeared in the 'American Monthly Microscopical Journal' for June 1887 a description of an analysing diaphragm for an eye-piece, to be used with the polariscope.

These two pieces of apparatus were to be used above the eye-piece, and were designed for a special kind of work. That now to be described is also to be used above the ocular, but for work of another sort. Its aim is to intensify the image of a certain class of objects, notably the Diatomaceæ, and its construction is shown in the accompanying figures, fig. 16 being a top view, fig. 17 an end view, fig. 18 an inside view, and fig. 19 is a sectional side view of the cap. The same letters in the different figures always refer to the same parts.

A, fig. 19, represents the axis of the Microscope; B, the eye-piece. G, fig. 16, the top of the eye-piece in which is a groove J. D is a sliding diaphragm moving in the groove from right to left and the reverse, by means of the screw F and spring I. Fig. 17 shows the manner of fitting the diaphragm in the groove.

To the under side of the diaphragm is fastened a square post H, by means of the screw L. This post gives motion to the diaphragm by the use of the screw F, and in the opposite direction by the spring I, which is supported by studs K.

It is very important that a proper adjustment of the diaphragm be made.

C, fig. 19, is the image of the mirror brought to a focal point through the eye-lens. It is at this point that the knife-edge of the diaphragm should be placed; the field will then have a subdued tint, and the object an exceedingly clear definition. Covering the point C with the diaphragm gives a *brilliant image of the object on a dark field*, and withdrawing the diaphragm from all contact with this point, the object will appear as ordinarily seen in the Microscope. I have obtained the best resolution of diatoms by the use of an achromatic eye-piece. I have also used Steinheil's 1 in. and 1/2 in. lenses as eye-pieces with good results.

The field under these eye-pieces assumes a soft grey tint the instant the diaphragm touches the point C. I do not find the use of the Huyghenian eye-piece to be satisfactory. I would strongly advise the use of the Nelson ocular.

* Microscope, x. (1890) pp. 8–10.

When using oblique light it is important that the diaphragm be placed on the side of the eye-piece nearest the mirror. For example, if the mirror is placed at the left of the stage, the screw F should be at

Fig. 18.

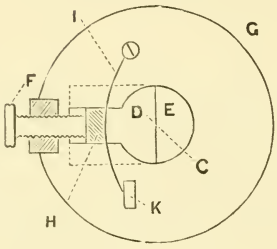
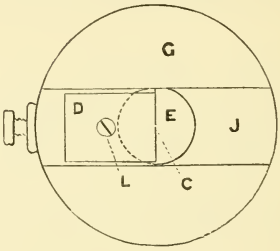


Fig. 16.



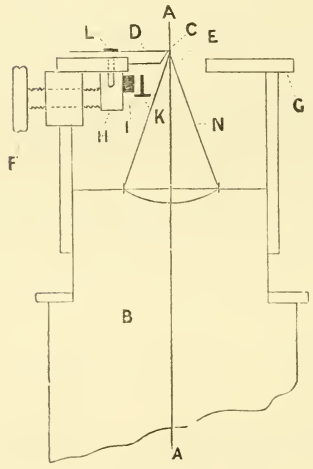


Fig. 19.

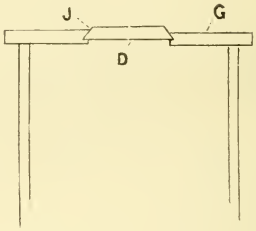


Fig. 17.

the left of the Microscope-tube. The eye-piece can be revolved to bring the diaphragm into the required position, and this revolving motion will also give a variety of beautiful effects.

The diaphragm works equally well with all objectives which I have used, and will, I think, repay all workers with the Microscope for the practice necessary to become familiar with its use.

Substage Condenser.* —Mr. Hyatt stated that the condenser which he exhibited to the New York Microscopical Society was constructed by himself on the principle announced some time since by Prof. Alfred M. Mayer—three plano-convex lenses, the largest one, of 2 in. focal distance, with a central stop, placed below, and two smaller lenses, paired, with their convex surfaces opposed to each other, and placed

* Journ. New York Micr. Soc., vii. (1891) p. 54.

near the under surface of the stage. The combination gives an excellent dark-ground illumination.

New cheap Centering Substage.—Mr. E. M. Nelson's substage, exhibited at the last November meeting,* is made thus:—The substage tube is made 1/4 in. larger in diameter than usual; a smaller tube, which holds the condenser, fits in this; this second tube has a large flange on the top, which prevents it passing through the large substage tube. A screw is cut on the bottom of the inner tube, and a flange similar to the upper one screws on. Obviously, therefore, by screwing the lower flange tight, the inner tube may be secured in any desired position.

(4) Photomicrography.

Handy Photomicrographic Camera.†—Mr. W. H. Walmsley writes: —Although photography in conjunction with ordinary microscopical observations (in other words, photomicrography) has undoubtedly grown in usefulness and popularity among workers with the Microscope during the past five years, there can be no doubt that its aid is very sparingly employed—a fact greatly to be regretted. For it is quite self-evident that the value of any microscopical research would be greatly enhanced, not only to the observer himself, but to his readers (in the event of his work being published), by full and accurate illustrations. Very few microscopists are competent draughtsmen, or capable of making drawings of objects under the lens at all correctly, or even presentable as illustrations thereof. And a drawing thus made is always permeated more or less by the imagination of the artist; so that the greater his skill in that direction the more likely is he to introduce features, not as rendered by the tube, but as he thinks he sees them. To be sure, photographic reproductions of microscopic objects are in a majority of cases not by any means perfect, or what one could desire, but they are vastly superior to almost any drawings in their accurate delineation of the various features of the specimen. The saving of time is another most important feature, as a dozen negatives may be taken in less time than that required to make a single careful drawing.

In the days of the old "wet-plate," the comparative insensitiveness of which precluded the use of a lamp as the illuminator, only those possessing a well-filled pocket-book or having access to the resources of a governmental or college laboratory could avail themselves of the aid of photography in connection with the Microscope. But the modern gelatin "dry plate" has placed in the hands of every one a cheap and efficient means of doing the highest class of work readily and perfectly. The very highest powers may be used with the light from an ordinary petroleum lamp. I have a print from a negative of *Pleurosigma angulatum* magnified 2400 diameters, by Spencer's 1/10 homogeneous objective; the illuminant being an ordinary single wick coal-oil lamp. It is the work of Dr. J. E. Baker, of Wyoming, Ohio, and is fully equal to the best work given to the microscopic world during the past six months.

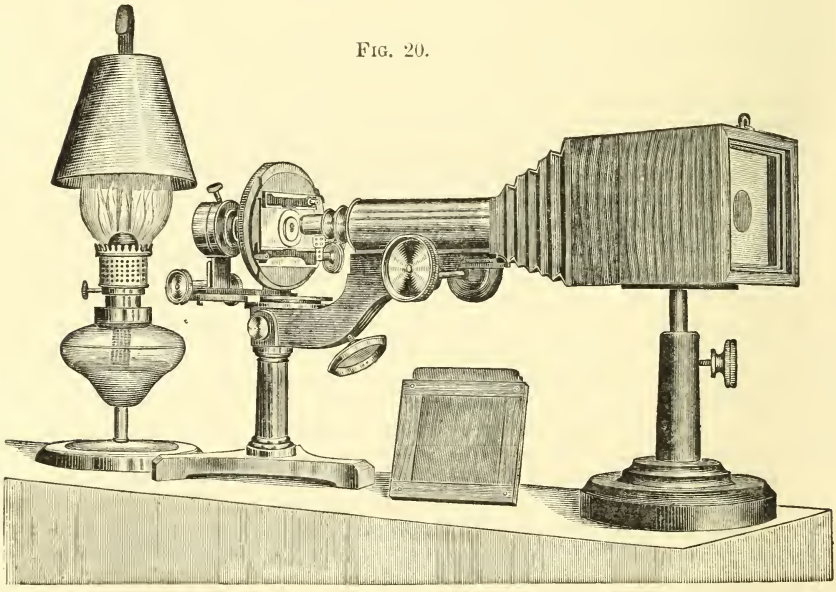
Why, then, has the use of photography not become more general

* See this Journal, 1890, p. 838.

† Amer. Mon. Micr. Journ., xi. (1890) pp. 257-61; and Proc. Amer. Soc. Micr., xii. (1890) pp. 69-74.

among microscopists? Simply from the fancied difficulties of the necessary but simple manipulations required; and from the real one of the absence of any form of camera which could find a regular and permanent home upon the work-table, occupying no more space than the Microscope itself, and always ready for immediate use. The latter is a most important requisite. How frequently does the student find in the course of his observations upon living and other tissues, features that are vital toward proving the truth of his researches, but so evanescent that the lapse of even a few minutes may suffice to obliterate them? If, then, there be at his elbow a small, simple camera which can be at once applied to the Microscope without the slightest alteration of the latter, save placing the body in a horizontal position, using the same source of illumination, be it diffused daylight or that of the ordinary lamp, has he not a boon within his reach, which a few years since would

Fig. 20.



have been deemed impossible? And are not his thanks due to the fellow-worker, whose own wants found expression in the original of the "Handy" photomicro camera?

My friend Mr. H. Wingate, of Philadelphia, has long been an ardent worker with the Microscope, his studies being almost exclusively confined to the minute fungi belonging to the family of Myxogastres. He is exceedingly skilful with the pencil, and his drawings of these minute organisms, their spores, &c., are at least equal to any that have ever come under my observation. But, being actively engaged in business, the time wasted in making these drawings was a large tax, and he determined upon calling in the aid of photography; and there being

absolutely no camera in the market to meet his requirements, he proceeded to construct one. Procuring a plate-holder of the proper size, he built the camera to suit it after the plan of the man who carried the bung-hole to a cooper shop to have a barrel made for it. His material was some heavy blackened cardboard, and an old piece of a steam-fitting some 4 in. long; his tools, a pocket-knife and a glue-pot, with the brains to use them. With these crude appliances he produced a camera, adapted to his Microscope, and capable of doing the highest class of work. He uses a Zeiss's 1/18 homogeneous lens constantly; and frequently makes a dozen or more negatives of an evening therewith.

Upon seeing this little affair, I was at once struck with the conviction that if it could be produced in a form adaptable to any Microscope, it would fully meet the long-felt want of just such an instrument. The result was the construction of the "Handy" camera, which has already been supplied to many institutions of learning and to private workers.

The camera consists of a mahogany box about $2\frac{5}{8}$ in. square, corrugated and blackened on the inside to prevent any reflections of light. A solid cone of some 4 in. in length, tapering to receive the tube of the Microscope, is attached to the front of the box. Preferably, this cone front should be in a bellows form, as in the sample sent, but this being rather more costly than the solid cone, many will be satisfied with the latter. In one case the bellows responds readily to the movements of the Microscope tube in focusing; in the other the tube must slide readily into and out of the solid cone. At the opposite end of the box is a groove, in which the plate-holder and frame containing the focusing screen slide. The former carries two plates $2\frac{1}{2}$ in. square, amply large for all ordinary illustrations. Should larger sized pictures be required they can be made by enlarging upon bromide paper.

The focusing screen is made of very thin crystal glass, most carefully ground by hand, presenting the smoothest surface obtainable by this means, but still quite too coarse for the exact focusing of delicately marked objects. In fact the focusing screen is mainly useful in procuring even and full illumination of the field, and in properly centering the object. The final fixing of the exact focus is done by means of a focusing glass used in conjunction with a disc of thin cover-glass attached to the ground surface of the screen by means of Canada balsam.

The camera is mounted upon a stout metal rod, which slides into the upright shaft of a very heavy japanned base, and can be secured at any height to suit that of the Microscope (when the latter is placed in a horizontal position) by means of a milled head. The base is shod with thick felt cloth, so that it may be placed upon any polished table-top without scratching the latter, and at the same time remain firmly fixed in the position it may be placed in.

And this is all there is of it: simple, compact, always ready for immediate service, and occupying no appreciable space upon the work-table. Although primarily intended for use with the Microscope-body inclined in a horizontal position, it may be as readily adapted to the latter in a vertical one, when the character of the objects (as those mounted in fluids) may require. My own method has been to remove the camera from its base and mount it upon the top of an open box con-

taining the Microscope. An opening in the top of the box allows the cone to be slipped over the tube of the Microscope, and in this manner I have made very successful negatives of blood-corpuscles in rouleaux in their own serum, yeast spores in fluid, &c. A correspondent in Boston writes me that he has mounted the camera upon a firm retort-stand for the same purpose. Many methods of using the instrument in an upright position will doubtless present themselves to the worker therewith.

The illumination may be by reflection from the mirror as in ordinary work, or by removing the latter and placing the lamp behind the stage in a direct line with the optic axis. It must be carefully centered in order to illuminate alike in all portions. Condensers of various kinds, bull's-eye, achromatic, Abbe, &c., can be used as desired, but only with moderate powers. The best results will be obtained by the employment of simple diaphragms of various sizes to suit, and so placed as to come as close as possible to the under surface of the slide upon which the object is mounted. All extraneous light should be excluded and none be allowed to enter the objective other than the rays which illuminate the specimen. Opaque objects may be photographed quite as successfully as transparent ones, but the time of exposure would be very greatly shortened by employing direct sunlight.

The eye-piece may be removed or not, as the observer may elect. Following the teachings and practice of the late Dr. J. J. Woodward, I have almost invariably worked without it, using an amplifier where sufficient magnification could not be obtained with the objective alone. In using medium and high powers, I have not found the eye-piece objectionable, but with low powers it certainly detracts from sharpness of definition, so that my preference is decidedly in favour of the amplifier where an increase of power beyond that obtainable with the unaided objective becomes necessary. If possible, however, always use the latter alone. The short tube-length, alone possible (when using the "Handy" camera), renders the employment of amplifier or ocular necessary, if enlargement beyond three or four hundred diameters is to be made, since the limit of a 1/18 used direct is less than 350°.

The corrections of most modern objectives as to visual and actinic foci, are so nearly identical that no difficulty will be experienced in obtaining sharp definition of any subject if a little care be used. But it may not be amiss to say the student's series of Bausch and Lomb are the best, by all odds, of any I have ever seen or used at all approaching them in moderation of cost. I have numerous remarkable examples of their work which I have never seen excelled by lenses of equal powers, no matter what their cost. It certainly is not necessary to go abroad in these latter days to get the best in the optical as well as in many other directions.

The dry plates for the "Handy" camera are furnished by the makers in two degrees of sensitiveness to suit every variety of subject. They are readily developed by any of the methods used for gelatin plates, my own preference being given to hydroquinone or a mixture of that with cikonogen, as giving the clearest results, clearest details, and sharpest contrasts with any desired amount of density. Their cost is but 25 cents per dozen, certainly cheap enough to tempt any one to their use.

In conclusion, a few words upon various printing methods. Pre-

suming that every microscopist who ventures into the realms of photography will do his own printing, a few hints may prove useful. There can be no doubt of the beauty and perfection of a good, properly toned, and finished print upon albumenized paper. This is conceded. But comparatively few amateurs will ever succeed perfectly in the operation of sensitizing the paper and toning the print, whilst most of the "ready sensitized" papers on the market are an abomination and a snare. Therefore avoid this method of printing, unless prepared to do first class work.

Passing by platinum as being both expensive and uncertain, excepting in the hands of an expert (although its beauty and perfection cannof be too highly extolled), let us consider for a moment the decided claim of bromide paper, as being the best material for printing in our class of work. Using the smooth surface paper and developing with ferrous oxalate, we get a perfect print rendering the most delicate details with the crispness and clearness of a steel plate engraving, which indeed it most closely resembles in very many instances. The exposure is made by lamplight, so that one is entirely independent of time or weather, and the finished print is quite permanent; as much so, it is reasonable to believe, as a carbon print. If the sheet be allowed to dry by itself, it will present the appearance of an ordinary plate engraving. If a polished surface be desired, all that is necessary will be to float the paper, print side down, upon a sheet of polished hard rubber; to squeeze it into optical contact, removing all superfluous moisture, and when quite dry it will peel off the rubber plate with a beautful polished surface, greatly increasing the delicacy of detail in many subjects, especially diatoms. Most decidedly my preference is given to this form of printing.

But there is another method which, at the risk of being laughed at, I am inclined to gently urge. I refer to the ferro-prussiate, or more commonly named "blue prints." This method of printing is tabooed in many instance, "blue prints" being rigorously proscribed in the albums of the Postal Photographic Club, but for all that it has decided advantages and merits for the work we are considering. It is cheap, as the paper may be purchased ready sensitized, at very trifling cost, and it requires no skill or experience in the using. It is merely necessary to expose to bright sunlight until sufficiently printed (a few experiments will determine this), and then to wash in several changes of water; the result being a bright permanent blue print upon a clear white ground, with excellent detail, excepting in the most delicate structures.

The negatives made with the "Handy" camera are of a convenient size for printing lantern-slides by contact. A print on glass is certainly the most perfect of any that possibly can be made, and the importance of this method of demonstration has long since been conceded. Gelatin plates coated on thin glass with special slow emulsions are furnished by several makers, and microscopists can readily make their own lantern slides with a little expenditure of time and patience.

On some Processes of Photomicrography.*—Dr. S. Capranica gives an account of the processes and apparatus which he employed to establish the results given in this Journal, 1888, p. 651.

* Zeitschr. f. Wiss. Mikr., vi. (1889) pp. 1–18.

(1) Apparatus for instantaneous photomicrography.—The author strongly recommends the use of the finder, with which it is possible to view simultaneously the preparation on the stage of the Microscope, and the projection of the image on the ground glass of the camera. The apparatus employed is a modified form of the Bourmans system. The camera is of wood, 30 cm. by 30 cm. and 12 cm. deep. On the front is a board, sliding in grooves, on which a metal flange with circular aperture of 5 cm. is screwed. A short tube carrying a shutter is attached to the flange. On this tube is screwed a totally reflecting prism in a circular metal box, having a right-angled tube of less diameter, to which is applied a stereoscopic binocular eye-piece of Abbe-Zeiss. The two eye-pieces of the latter are unscrewed and replaced by two other tubes. The tube replacing the straight eye-piece is of the same length, and can be fitted with slight friction into the socket of the vertical tube of the prism-box. The other tube replacing the inclined eye-piece has a rack and pinion motion, and can be lengthened by the addition of other pieces of tube of the same diameter. The finder having been arranged, the tube of the stereoscopic eye-piece is placed in that of the Microscope, and by a strong binding screw the foot of the instrument is fixed to the work-table. A special slide, which serves the triple purpose of plate-holder, support for the ground glass, and shutter, consists of a square box, provided with two cylinders, on which is rolled a band of black sheet indiarubber completely light-proof. A screw button presses on the spring, which by a pneumatic release sets the cylinders in motion. On drawing a silk thread, the indiarubber sheet unrolls itself on the cylinders and, traversing with great rapidity the free surface of the slide where the sensitive plate is exposed, returns instantly to its first position. The maximum rate of passage of the indiarubber band was 1/20 of a second. Since the shutter is placed at the back of the camera, the shock of its release can only very slightly affect the Microscope.

The author in all his experiments made use of the large Microscope of Koritska, and considers that the apochromatic objectives supplied to him by this maker are in many respects superior to those of Zeiss. The polarization apparatus is disposed as in the Nachet petrographical model. The micrometer screw has a divided head and reads to the 500th mm. with great exactness. For very delicate work the author used the stand (large model) of Powell and Lealand, or a Ross stand with swinging tail-piece for oblique light. When powerful condensing systems were used, a special cell containing a saturated solution of alum was placed beneath the stage, and the rise of temperature was noted by a thermometer.

The indispensable condition for success with a high-power objective, as e.g. a 1/25 immersion, is to have a sufficiently strong illumination. To a bad illumination of the image the author attributes most of the faults usually noticeable in photomicrographs.

(2) Apparatus for the reproduction of consecutive movements of microscopic creatures.—Experiments made by the author with one of the first photographic cameras of Stirn succeeded sufficiently well to induce him to make it the basis of the apparatus which he subsequently employed. This camera consists of a circular box, 2 cm. thick,

having a shutter, with a continuously intermittent release, each movement of which simultaneously caused a circular sensitive plate to advance by a sector. Of this camera only the shutter in the front of the apparatus was retained. This was fixed to the plate of a camera similar to that described in (1). The two special slides designed by the author have a clockwork movement. The one for use with a glass sensitive plate consists of a rectangular box 20 cm. by 20 cm. and 5 cm. deep. At the centre of the box is a metal wheel, put in motion by a clockwork arrangement at the back of the slide, which is provided with an escapement pneumatically regulated. In the metal wheel are fixed the sensitive plates, of the same size as those used in the Stirn camera. This part of the slide is protected from light by a screen, which is placed on a frame in such a way as not to interfere with the movement of the wheel. The screen is pierced with a circular aperture of 5 cm., placed in a line with the aperture of the shutter. The focusing is effected either by Moitessier's method, or by the substitution of a ground glass for the slide. When the slide has been placed in position, the finder, previously described, is fixed by a screw tube in the shutter. As soon as focusing is finished, the slide is charged with the sensitive plate, and successive photographs are taken of the movements of the object on the stage, while it is kept under observation the whole time with the finder. The disadvantage of this slide is that with it only a very limited number of proofs can be obtained. The apparatus devised by the author to remedy this defect can give theoretically 250 impressions of 9 cm. by 9 cm. in a minute. This second slide is a modified form of that of Eastman.* A band of very sensitive negative paper is rolled in turn on two cylinders. A powerful clockwork arrangement placed at the top of the slide effects the movement of the sensitive paper. A lever, pneumatically regulated by a caoutchouc ball, communicates with the spring which sets the clockwork in motion. The rest of the apparatus is in all respects similar to that first described.

The first of the two slides was constructed at Milan by Mr. Oscar Pettozzi, and the second at Genoa by Mr. Ettore Guelfi.

New Flash-light for Photography.†—Dr. Thomas Taylor made an exhibition of his new discovery before the Washington Chemical Society, which, it is believed, will supersede several now in use for photographing at night. The composition consists largely of charcoal made from the silky down of the milk-weed—a form of carbon which he prefers to all others, because of its freedom from ash. A few grains being placed on tissue paper and ignited by a punk match, produces a prompt and blinding flash, while it was observed that the paper on which the powder rested was not even scorched, thus demonstrating the greater security from accidents.

Notes on Photomicrographic Prints exhibited at Meeting of R.M.S. on 19th November, 1890.—Mr. A. Pringle writes as follows regarding the remarks made on his prints by Dr. Dallinger and Mr. E. M. Nelson.‡

(1) Photographs of *B. termo.*—Mr. G. F. Dowdeswell, F.R.M.S., is

* M. A. Londe's 'La Photographie Moderne,' 1888, p. 22.

† Microscope, x. (1890) p. 190. ‡ See this Journal, 1890, pp. 836-7.

responsible for the nomenclature *B. termo*. The organism corresponds with sufficient accuracy—allowance being made for the somewhat vigorous treatment in staining—with the measurements, and also with the behaviour in cultivation, of Cohn. The staining was effected by the method of Loeffler—modified, I understand, by Mr. Dowdeswell—tannin and iron sulphate being used as a mordant. The photographs exhibited, and about ten others not shown, were obtained with an apochromatic 2 mm. glass by Zeiss, projection ocular, and a dry condenser, nominally of N.A. 1, also by Zeiss.

The preparation viewed with the named objective and compensating oculars Nos. 8 and 12, shows the flagella apparently as long and almost as wide as they are shown in the photographs. That is to say, that the flagellum so viewed varies from twice to six times as long as the "body" of the organism, and in some cases the flagella seem to be even longer in proportion to the bodies than six times.

I agree with Dr. Dallinger that, as a rule, *B. termo*, unstained, or slightly stained, or stained without the use of Loeffler's mordant, shows a flagellum about one and a half times the length of the body. Until I saw late preparations by Mr. Dowdeswell, I had never seen flagella nearly so long attached to *B. termo*.

Dr. Dallinger appears to attribute the great prolongation as well as an "extremely rotten" appearance, or "imperfectly defined edge" to imperfections inherent in, or frequently found in, photographic representations of microscopic images. It is difficult to conceive the operations or the optics concerned in photomicrography producing such a very remarkable prolongation of a flagellum as that with which we are dealing. But in respect of the width of the flagellum, much may be said on a certain shortcoming of photography. The phenomenon known as "lateral development" has a marked bearing on photographic images of very minute objects, such as the case in point. The silver is not reduced, I believe, precisely at right angles to the surface of the vehicle-film, there is a certain amount, varying no doubt with the nature and properties of the vehicle, of "spreading" of the silver image through the menstruum containing it, hence (among other reasons) a negative image is never quite so "sharp" as the image projected on the film. This action of lateral development takes place twice in the production of a print; first, in the production of a negative; second, in the operation of printing. Further, I believe that this lateral reduction takes place to a greater extent in printing processes where the image is revealed by development, and I believe that the gelatin processes of photography are more apt to favour this phenomenon than, for instance, albumen processes.

The negatives and the prints exhibited were produced by development processes on gelatin films, and, moreover, the prints were left with surfaces more or less "matt"; and it is probably not stretching any point to say that the fact of the width of the flagellum on the print being at least 50 per cent. greater than if accurately represented it would be, is accounted for by the photographic imperfections I have named. The inaccuracy in the length of the flagella due to these causes is so slight as to be negligible.

Photomicrography in Space.—Dr. Fayel, President of the Société Linnéenne de Normandie, communicated to that Society * a note on this subject which we translate:—"Under the designation of *Photography in space*, Dr. Fayel records a process of his invention which facilitates the observation of opaque objects by the Microscope, even with powerful objectives, and which he thinks will hence render important service. Instead of focusing directly upon the object, Dr. Fayel allows the image to be projected on the ground glass of the photographic camera, and then removes the ground glass and examines the aerial image with a Microscope. In order to reduce the labour of adjusting the Microscope, it should first be focused very near the plane of the ground glass. The image appears so sharp that the minutest relief-forms of the opaque object may be observed by manipulating with the fine-adjustment screw."

(6) Miscellaneous.

Liquid Crystals.†—Prof. O. Lehmann has been able to demonstrate the remarkable fact that three organic substances at certain temperatures, although actually in a liquid state, show strong doubly refracting power, and may therefore be regarded as anisotropic crystals.

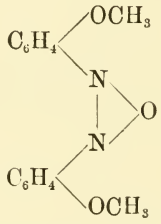
All crystals hitherto known consist of solid aggregates. The author has previously shown, however,‡ that some crystals can be made to flow when subjected to pressure exceeding the limit of elasticity. This has been long known with respect to amorphous bodies like sealing-wax and soft glass. Bodies like these pass, by increase of temperature, continuously out of the solid into the liquid state, i. e. the limit of elasticity gradually diminishes until at a certain critical temperature its value is zero. Beyond this temperature the body is liquid, and the smallest force is capable of causing it to flow. If a crystal then possesses a very low limit of elasticity, it can be made to flow, just as a liquid can, by means of a very slight force. The question therefore arises whether a crystal could not have an elasticity limit zero, and thus be referred no longer to solid but to liquid bodies.

According to the prevailing ideas, which receive their most perfect development in the theory of Soncke, this should be impossible; for this theory supposes that the molecules of crystals form regular point systems, held in position by the elastic force. The author, however, considers that this theory is unsatisfactory when the physical instead of the purely geometrical relations of crystals are considered. If the existence of a crystal as such depend on a regular distribution of the molecules, long continued deformation should at length lead to the production of a body not possessing this regular arrangement, i. e. to an amorphous substance. Experiments, however, made by the author showed that no amount of deformation was capable of converting a crystal into anything resembling in any way an amorphous body. Having regard to this slight correspondence of the theory with fact, the idea of a liquid crystal appeared to be justifiable. One distinction between crystalline and amorphous bodies is the capacity possessed by the former alone of growth in a supersatu-

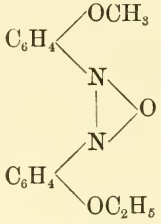
* Bull. Soc. Linnéenne de Normandie, iii. (1888–9), p. 13.
† Pogg. Ann., xl. (1890) No. 7, pp. 401-23.
‡ Zeitschr. f. Phys. Chem., iv. (1889) p. 462.

rated solution. Now almost all known liquids possess this property, so that, to be consistent, they should be considered as crystallized, and, since they are isotropic, as belonging to the regular system. The three organic substances which form the subject of the paper are examples (at present the only ones known) of liquid crystals which are anisotropic. They are:—

1. Azoxyphenetol.
2. Azoxyanisol.



3. Compound of the composition



The following observations apply to all three alike.

The normal form of crystal drops.—Crystals of the substance under examination, placed on the stage of the Microscope under a cover-glass, were melted and then allowed to cool again to the point of crystallization. On again warming and examining between crossed nicols, at a certain temperature (134° for azoxyphenetol, 116° for azoxyanisol, and 87° for the third substance), a sudden transformation into strongly doubly refracting crystals took place. These newly formed crystals preserved the same form as the first, but were seen by pressing down the cover-glass to be not really solid, but liquid. By warming still further, at a definite temperature (165° for azoxyphenetol, 134° for azoxyanisol, and 140° for the third substance), they passed into the ordinary isotropic liquid modification. In order to isolate the liquid crystals a solvent in the shape of Canada balsam was used. By then heating to a temperature above their point of fusion, and subsequently cooling, the crystal drops separated out from the solvent in perfect spheres, which in ordinary light showed peculiar shading effects, most of them like fig. 1 or fig. 2 (Plate V.). These figures really represent the same object in different positions. The shading effect is due to irregularities of refraction, like the "Schlieren" seen in amorphous bodies when examined under oblique illumination by Töpler's "Schlieren-apparatus." *

* Pogg. Ann., 127 (1866) p. 556.

Between crossed nicols fig. 1 appears as fig. 3 * with a black cross, fig. 2 as fig. 4*a* or 4*b*, dark or clear, according as the long "Schliere" is parallel or inclined to one of the directions of vibration of the nicols.

The distribution of the directions of extinction for the individual points of the drop is given by the curves represented in figs. 5 and 6. They correspond to the electric level surfaces and lines of flow in a conducting sphere in which the current enters and emerges at the extremities of a diameter. Regarding a drop as composed of uniaxial crystal particles, the optic axes must be considered as arranged in positions corresponding to the lines of flow, and the equatorial planes as representing the level surfaces. An optically uniaxial crystal in which the limit of elasticity is zero must assume such a form. For the surface tension between crystal and liquid will possess different values on the different crystal faces; but since there is no counteracting elastic force, the molecules will change their positions until the surface tension has everywhere the same value, and that the smallest possible, since the potential surface energy tends to a minimum. The molecules will accordingly arrange themselves so that they all present the same side outwards.

By the use of the polarizer alone indications of dichroism are obtained. Thus, when the long "Schliere" is parallel to the short diagonal of the nicol, the crystals appear colourless and with faint outline; when at right angles, yellow and sharply defined.

Deformation of crystal drops.—By pressing the drop between stage and cover-glass the principal form (fig. 1) changes to that shown in fig. 7. In this the "Schlieren" have given place to a sharp nucleus at the centre and another around the circumference of the disc. Between crossed nicols the appearance is the same as before, except that the quadrants show colour differences. By suitable pressure on the cover-glass the central nucleus can be made to approach the edge and finally to take up a position between the broken ends of the marginal nucleus (fig. 8). By further deformation the two nuclei pass through various transitions until the symmetrical form of fig. 9 is obtained. By then diminishing the pressure until the drop once more assumes the spherical shape, the simple form of fig. 2 is obtained. Thus the total effect of the series of changes has been to turn the drop through 90° about a horizontal axis.

More exact observation with greater magnifying power showed the peculiarity in the spaces between the two nuclei seen in fig. 10. This was found to be due to a rotation of the whole drop in a direction contrary to the hands of a watch. The rotation was so much more rapid, the greater the difference in temperature between stage and cover-glass. On account of the friction of the glass and because the rotating force mainly affected the circumference, the outer layers became distorted with respect to the inner. Fig. 11 represents a much twisted drop produced in this way. Between crossed nicols it showed concentric dark rings with alternating white and yellow ones.

With very rapid rotation the ends of the nuclei bend towards the

* The punctuation in the figures denotes, according to thickness, pale to dark yellow.

centre (fig. 12), and finally a double spiral filling the whole space may result (fig. 13).

Another effect of heat is the production of local rotations about horizontal axes. A portion of the marginal nucleus may thus be drawn into the interior of the drop (fig. 14); a fresh nucleus then forms on the edge, and may follow the first, and so on until the whole surface becomes covered with parallel nuclei (fig. 15).

When a flattened-out drop is very strongly heated, it is gradually dissolved, and, in consequence of the above movements, the thickness diminishes most quickly at the centre. Accordingly a hole is soon formed, and the drop is changed into a ring. At the moment of production of the hole, one or two nuclei form on its edge. The same thing happens when there is an air-bubble in the interior of the mass (fig. 16). For this case the structure lines are represented in fig. 17. They correspond exactly to the electric lines of force in a dielectric, into which an insulated conducting sphere is brought. Effects similar to those produced by heat can be brought about by mechanical means. Fig. 18 represents the effect of the passage of an air-bubble into a large mass, by which the nuclei are drawn out into parallel threads, like the "oligen Streifen" observed with cholesteryl benzoate.

Division of crystal drops.—When an ordinary liquid crystal is cut into two parts, each part forms a new individual with spherical form and nucleus like the original. Fig. 19 *a*, *b*, *c*, shows the division of a crystal by means of an air-bubble; the crystal is first deformed, and then cut into two parts.

Copulation of crystal drops.—In the case of two drops with central nuclei the union of two into one may take place in two ways, either by the two nuclei closing up to the double nucleus in the centre of the compound drop, or by one nucleus being driven off to the edge, while the one-half of the compound drop grows at the expense of the other. The first process is represented in figs. 20 *a*, *b*, *c*, to 23 *a*, *b*, *c*. One of the processes by which two drops with marginal nuclei may unite is explained by figs. 24 *a*, *b*, *c*, 25 *a*, *b*, *c*, and 26 *a*, *b*, *c*. The ultimate form taken by the complete union of two drops need not be the only possible stable one. Quite stable intermediate forms may occur, especially where several drops are united. Figs. 27, 28, and 29 show some examples of the copulation of drops with central nuclei.

With regard to the copulation of *dissimilar* crystals, it was found that any one of the three organic substances could unite with any other. Their properties, however, were so similar that no striking result was obtained.

In support of the contention that optically isotropic liquids should be considered as liquid crystals belonging to the regular system, the author brings forward the following considerations. In the conversion of a substance into an allotropic modification the newly formed crystals generally occur regularly orientated with respect to the earlier ones. Now suppose that in a fused mass of regular crystals this orientating effect acts upon the crystallized modification resulting from solidification, and the latter upon the liquid crystals formed by the fusion. Then by repeated fusion and solidification the visible solid crystals, as well as the invisible liquid ones, should always occupy the same positions,

and be of the same size, provided that internal currents are guarded against.

Some such effect the author obtained, not, however, by conversion of a fused mass into a solid modification, but into a liquid crystallized one. To avoid currents in the fused mass, special care was taken to have everything perfectly clean, and only very slight thickness was given to the liquid layer between stage and cover-glass. In this capillary space one of the three substances was heated until the solid crystals were converted into the doubly refracting liquid modification. This occurred in regular orientation with respect to the solid crystals, i.e. a copy of each in its outline was obtained, but with other interference colours and different directions of extinction. On heating still further, until the doubly refracting liquid was converted into the singly refracting, the field of view between crossed nicols became dark by the widening out of dark circular spots which formed in the doubly refracting mass. The fused mass was then cooled down again, when the doubly refracting liquid crystals again appeared with precisely the same outline and directions of extinction as before. The author considers that this experiment serves to strongly support the idea that non-doubly refracting fused masses are regularly crystallized enantiotropic modifications. That doubly refracting liquids are so rare as to have hitherto escaped discovery, receives some explanation from the fact that with substances having many enantiotropic modifications, the crystal system, with increased temperature, tends to a higher degree of symmetry, and thus finally to the regular system.

On the History of the Invention of Spectacles, Microscope, and Telescope.*—Herr C. Landsberg shows on what uncertain grounds it was that the year 1890 was regarded as the 600th anniversary of the invention of spectacles, and the 300th of that of the Microscope. It is impossible either to fix a precise date for these inventions, or to give with certainty the names of the inventors. The art of cutting and polishing precious stones was known to the ancients, and among the relics of this art we posses lenses, both convex and concave, which are at least 3000 years old, e.g. the plano-convex lens of rock-crystal discovered by Layard in the ruins of Nineveh. It can scarcely be doubted that the men who made these lenses were acquainted with their magnifying power, and in fact made use of it in the execution of those delicate engravings on gems which have been handed down to us. An exact description of the effect of spherically-cut glass is, however, not to be found in ancient literature; but Pliny mentions that the near-sighted Nero looked at the gladiatorial games through a smaragd. The Arabian physician Alhazen (about 1100 A.D.), who was the first to give an exact anatomical description of the eye, showed by his writings that he knew the magnifying effect of a segment of a sphere made of a denser material than the air. Later writers on optics refer to the observations of Alhazen, but add nothing to them. To Roger Bacon (1216–1294), however, much more extensive knowledge is ascribed. He is often credited with the invention of eye-glasses and the telescope. All that can be gathered from his writings

* Central-Ztg. f. Optik u. Mechanik, xi. (1890) pp. 265, 277.

is that he possessed plano-convex lenses and knew their magnifying power ; that he attributed this power to the fact that the lenses made it possible to see objects under a greater angle ; and that he perceived how useful such lenses might be for people with weak sight. There is no evidence, however, to show that he was actually the inventor of spectacles. That honour, it appears, must be divided between Alexander de Spina of Pisa, and Salvino degli Armati of Florence, for an old chronicle of the monastery of St. Katharina, in Pisa, ascribes it to the first. while an inscription discovered on a tombstone in the church of Maria Maggiore, in Florence, gives it to the second. The first authenticated notice of the use of glasses for weak sight is contained in a letter dated 1299, and Jordan di Rivalto, in a speech made in the year 1305, refers to the invention of spectacles as being then scarcely twenty years old. Thus the date of the invention was close at the end of the thirteenth century, but no precise year can be given. For the next three centuries no advance in the theory of optics appears to have been made, and it was not until the beginning of the 17th century that the Microscope and telescope were invented. Italy and Holland both claim the honour of the invention, and each of these nations brings forward different names. There is very little doubt that the honour belongs to Hans and Zacharias Jansen, father and son, glass-cutters of Middelburg. Evidence in support of their claim by the son and sister of Zacharias Jansen, and by Wilh. Borell his friend, is contained in a paper by Pet. Borelius on the invention of the telescope which appeared in 1655. According to the description given by Borell, the short-tube telescopes (Microscopes) made by the Jansens were about $1\frac{1}{2}$ ft. long. The tube, which was about 2 in. in diameter, was supported by three brass dolphins, and had a base of ebony on which the small objects to be examined were laid. The long telescope, or telescope proper, was not made by the Jansens until some time after the Microscope. A rival claimant for the honour of this invention is Lepreg, or Lipperstey, or Lipperheim, another glass-cutter of Middelburg. He certainly did construct a telescope, and was able to exhibit it to a stranger who came to Middelburg (probably about 1608) in order to make inquiries about the new invention ; but whether his instrument was made independently or only in imitation of that of the Jansens it is impossible to say. In Italy, Galileo is generally accepted as the inventor of the telescope, but, as he himself allows, it was not until after he had heard of the Dutch invention that he attempted to construct an instrument for himself. To him is due the credit of being the first to direct the telescope to the heavens; and with its aid in 1610 he made the discovery of Jupiter's satellites. Although the earlier discovered, the Microscope was almost unknown beyond its birthplace at the time when the telescope was in all hands. Thus Cornelius Drebbel, who exhibited an instrument in London in 1621, was looked upon as the inventor, and is so described by Huyghens and many others.

Similarly, in Italy, the Microscope was unknown until about 1624. One explanation of this may be found in the fact that the instruments were then very incomplete. For the long series of improvements, both in the optical and mechanical parts, which has led to the perfection of the instruments of to-day, the present century is mainly responsible.

Microscopes, Microtomes, and Accessory Apparatus exhibited at the Tenth International Medical Congress at Berlin.*—At this exhibition there appears to have been a very fair show of instruments specially adapted for medical and pathological work. Most of the chief firms were represented, the greater number, of course, being German. Novelties were apparently conspicuous by their absence, the exhibitors' claims to inspection being chiefly for thoroughness and effectiveness, such as a Microscope with movable stage and nose-piece with four objectives, and a similar instrument fitted with Mayall's stage.

Microtomes were in full force: besides the commonly used sliding microtomes and freezers, the less known instruments for cutting under water, automatic microtomes, and Altmann's "Support-Mikrotom," were exhibited.

International Exhibition at Antwerp.—A circular letter has been issued regarding the "Exposition de Microscopie Générale et Rétrospective," to be held at Antwerp in August and September next.

The Executive Committee consists of M. Charles de Bosschere, President, Dr. Henri Van Heurck, Vice-President, MM. Edmond Grandgaignage and Gustave Royers; M. Charles Van Geert, junr., is General Secretary, and M. Ferdinand Van Heurck is Secretary.

The Honorary Presidents are Prof. Abbe, Mr. F. Crisp, and M. Nachet. Among others of the Honorary Committee are Prof. Strassburger, Dr. W. J. Behrens, Dr. E. Hartnack, Dr. Rod. Zeiss, and Dr. Sieg. Czapski, from Germany; Sir Joseph D. Hooker, Mr. John Mayall, junr., Mr. Julien Deby, Dr. Maddox, and the Rev. Dr. Dallinger, from England; Dr. Cox, Dr. H. Ward, and Prof. Hamilton L. Smith, from the United States; Dr. J. Pelletan and Dr. P. Miquel, from France; Dr. Engelmann, from Holland; the Abbé de Castracane, from Italy; and Dr. P. T. Clève, from Sweden.

The following is the "Programme de l'Exposition de Microscopie":—

Classe I. *Microscopes pour toutes les recherches courantes.*—A. Microscopes à platine et à sous-platine ("substage") à mouvements mécaniques. Modèles à tube anglais et à tube continental. Microscopes ordinaires pour recherches usuelles. Microscopes à bon marché pour les études élémentaires. B. *Microscopes spéciaux.* — Microscopes binoculaires. Microscopes pour la minéralogie et la pétrographie. Microscopes comparateurs. Microscopes spéciaux pour la photographie. Microscopes renversés. Microscopes de voyage. Microscopes de poche. Microscopes de démonstration. Microscopes à deux ou plusieurs corps. Microscopes pour musées à platine portant de nombreuses préparations etc. Microscopes de projection. Objectifs et oculaires. Objectifs achromatiques et apochromatiques. Objectifs à sec, à immersion dans l'eau, à immersion homogène, etc. Oculaires: de Huygens, de Ramsden, holostériques, compensateurs, à projection. Appareils optiques pour l'éclairage. Condenseurs achromatiques et non-achromatiques.

Classe II. *Appareils d'éclairage.*—Lampes à pétrole. Lampes à gaz. Appareils pour la lumière oxyhydrique. Appareils pour l'éclairage électrique à arc, à incandescence. Piles électriques spéciales.

* Central-Ztg. f. Optik u Mechanik, Oct. 15, 1890.

Classe III. *Appareils pour la photomicrographie.* — Microscopes spéciaux. Chambres photographiques diverses. Photomicrogrammes.

Classe IV. *Appareils divers.*—Appareils binoculaires ajustables à volonté sur des microscopes quelconques. Revolvers; adapteurs; spectroscopes-microspectromètres. Appareils de polarisation. Chambres claires: pour microscope vertical, pour microscope incliné, pour microscope horizontal. Goniomètres, hématimètres, chromomètres. Chambres de culture ("Growing-cells"). Compresseurs. Platines à chariot indépendantes du microscope. Prismes redresseurs, oculaires redresseurs, oculaires binoculaires, oculaires stéréoscopiques. Plaque de diffraction d'Abbe. Appareil à échauffer l'objet sous le microscope. Appareils divers non mentionnés.

Classe V. *Appareils de mensuration* pour l'oculaire, pour la platine; appareils de mensuration pour les couvre-objet.

Classe VI. *Microtomes.*—A mouvements mécaniques, à main. Appareil à diviser pour tracer les micromètres et les tests dites de Nobert.

Classe VII. *Appareils et accessoires pour les préparations microscopiques et les dissections.*—Microscopes simples, doublets, loupes montées.

Classe VIII. *Préparations microscopiques.*—Préparations de toute espèce. Préparations simples. Préparations systématiques. Typen-Platten et Test-Platten.

Classe IX. *Appareils pour la bactériologie.*—Étuves à culture. Étuves à températures basses et constantes. Étuves à stériliser par l'air sec et par la vapeur. Appareils pour la coagulation du sang. Appareils pour la stérilisation des sérums. Boîtes pour désinfecter les instruments et pour stériliser les plaques à gélatine. Régulateurs pour la pression du gaz. Lampes inextinguibles et lampes se fermant automatiquement lorsque la flamme s'éteint. Appareils pour les recherches des microbes dans l'air et dans l'eau. Verrerie pour bactériologie (ballons, tubes, billots, plaques, entonnoirs à eau chaude, crochets, etc.).

Classe X. *Ouvrages de microscopie.*—Traités de micrographie. Ouvrages traitant de toutes les applications du microscope.

Prof. Gilberto Govi.—He was born at Mantua in 1834, and was educated at Turin and Florence, subsequently taking the professorship of physics at the University of Naples. He died on 29th June, 1889. At his funeral the President Brioschi, of the Accademia Reale dei Lincei, referred in high terms to the great capacity of Govi, and to his ardour in historical research in difficult points connected with scientific discovery. He was a frequent contributor to the transactions of the learned societies of Italy, and was particularly versed in the literature of electricity and optics. He made a special study of the labours of Volta, and threw much new light on the varied attainments of Leonardo da Vinci, to whose manuscripts he had access at the Biblioteca Ambrosiana of Milan. Govi's contributions to microscopy, theoretical, practical, and historical, were numerous. Most of his devices were carried out in conjunction with M. Alfred Nachet, the optician, of Paris. His latest historical research was an elaborate paper communicated to the Reale Accademia dei Lincei, in which he sought to establish the invention of the compound Microscope by Galileo; this paper we

translated and published in this Journal, 1889. Govi was elected an Honorary Fellow in 1888.

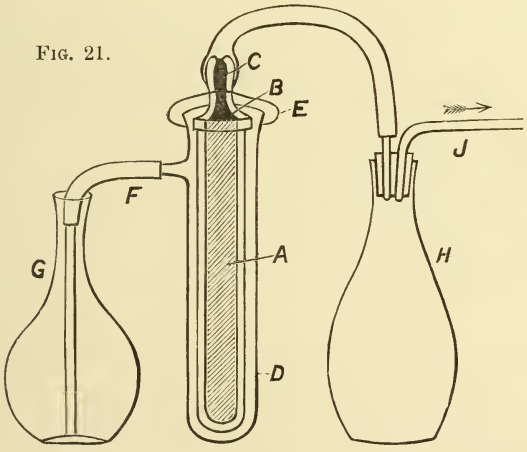
Mr. A. P. Schulze.*—Our readers will regret to see the announcement of the death of Mr. Adolf Paul Schulze, F.R.S.E. and F.R.M.S. Mr. Schulze was a yarn merchant in Glasgow, and made the study of microphotography, microscopy, and optics, the special pleasure of his spare time. Born in 1840 at Crimmitschau, Saxony, he was educated at the Polytechnic of Chemnitz, where he studied engineering, and came to England in 1864, ultimately settling in Glasgow in 1869. He made the subjects above named his special study, and was known from his scientific work to the leading men in all that is comprised in the term "optics," Prof. Abbe, of Jena, being in regular correspondence with him. Perhaps it would be too much to say that Adolf Schulze's life was lived in the wrong place; but for a busy man, in the commercial sense, he did much in the interests of science—so much as to give an idea of what he might have done had it been possible for him to have devoted himself to research.

β. Technique.†

(1) Collecting Objects, including Culture Processes.

Simple Apparatus for filtering Sterilized Fluids.‡—The apparatus invented by Dr. O. Bujwid consists of a Chamberland bougie A, about

Fig. 21.



15 cm. long and 2–3 cm. thick. Upon the top is placed a sort of cover B, through which runs a hole C. These two parts are very easily sterilized with steam or hot air. When required for use, the arrange-

* Engl. Mech., lii. (1891) p. 440.

† This subdivision contains (1) Collecting Objects, including Culture Processes; (2) Preparing Objects; (3) Cutting, including Imbedding and Microtomes; (4) Staining and Injecting; (5) Mounting, including slides, preservative fluids, &c.; (6) Miscellaneous.

‡ Centralbl. f. Bakteriol. u. Parasitenk., ix. (1891) pp. 4–5 (1 fig.).

ment is as seen in the illustration. The filter is placed in a test-tube D, and the air therefrom is exhausted by means of an air-pump. Hence the fluid to be filtered flows from the flask G, through D and C to H. Between the bottom of the porcelain filter and the test-tube, a piece of cotton-wool is placed.

Apparatus for cultivating Anaerobic Microbes.*—Dr. C. Brantz has invented an apparatus for the better cultivation of anaerobic micro-organisms. The apparatus, which is depicted but not described, consists of a holder or receiver for the solution of pyrogallic acid. It is placed beneath the slide and has two apertures, one of which opens into the chamber where the organisms are being cultivated in hanging drops, while the other is for connection by means of a caoutchouc tube with an apparatus for developing hydrogen gas. The receiver is capable of containing 5 grm. of the pyrogallic acid solution.

(2) Preparing Objects.

Method of investigating Development of Limax maximus.†—Miss Annie P. Henchman found that the best way of obtaining embryos was to keep adults, say twenty-five or thirty, in a large tin pail, the cover of which was perforated with small holes. It is best to feed them on cabbage, which affords them a sufficient protection against desiccation, and a place where they may lay their eggs. Care must be taken to keep the vessel clean. Eggs were generally found in the morning, in bunches of from thirty to forty. As they are more abundant in the early stages of confinement, it is better to obtain a few slugs often than many at once. The eggs must be carefully protected from drying. In a moderately warm room hatching occurs between the twenty-second and the twenty-seventh day.

The best agents for killing embryos are either 0·33 per cent. chromic acid or Perenyi's fluid. The chromic material, when well stained with alcoholic borax-carmine, shows the differentiation of nerve-cells and nuclei excellently. Good results for the study of cell-division have also been obtained by staining with Czokor's cochineal. Picro-carminate of lithium is valuable in later stages, as it brings out nerve-fibres, which are stained yellow, while the ganglionic cells are coloured red.

It is best to remove only the outer envelope before killing the embryos, as they are thus less likely to be injured. The inner membrane may be removed with needles after the eggs have been dropped into water to which a few drops of acid have been added. The embryos will be found to be very delicate, and must be handled with great care through every step of the process. Miss Henchman employed only the chloroform method of imbedding in paraffin. The embryo should be carried through the period of heating as quickly as possible, for the embryos are very apt to become brittle if subjected to the heat too long. They should be imbedded within an hour, or an hour and a half, from the time they are first put upon the bath in the chloroform. Paraffin

* Centralbl. f. Bakteriol. u. Parasitenk., viii. (1890) pp. 520–1 (1 fig.).
† Bull. Mus. Comp. Zool., xx. (1890) pp. 171–5.

which melts between 50° and 52° C. is better for imbedding than that which is harder, for in the latter the embryo may be cracked.

Sections from 10 to 15 μ thick, and in the oldest stages even thicker, are better than those that are very thin.

Method of observing Asexual Reproduction of Microstoma.*—Dr. F. von Wagner kept his living specimens of *Microstoma* in small breeding aquaria, 15 cm. long, 10 cm. broad, and 6 cm. high; and he did his best to reproduce the natural conditions of their existence without diminishing the opportunities for observation. A thin layer of mud was spread on the floors of the vessels, and food was provided in the shape of abundance of Daphnids of various sizes. Only a few plants were admitted, and they were, therefore, renewed completely every week. Care was taken to prevent the entrance of any other animals. Notwithstanding all this care, the specimens did not live for more than two or three weeks.

The animals, when required for measurement, must be carefully drawn out with a pipette, placed in a small watch-glass, and measured with an eye-piece micrometer. Great patience is needed.

Various preservative reagents were tried, and a concentrated watery solution of sublimate was found the best. Lang's fluid and a half per cent. osmic acid solution often gave good results. Weigert's picro-carmine was used for staining, and sections 1/100 to 1/500 mm. in thickness were cut.

Examining Bone Marrow for developing Red Corpuscles†—Herr E. Neumann says that phases of the development of the red blood-corpuscles may be observed by obtaining bone marrow in the following manner:—The marrow is squeezed out of some cancellated bone by means of a vice, and a small quantity of this taken up in a capillary tube and placed on a slide. Having been covered, it is examined directly without any addition. By this means good results can be obtained from ribs of human bodies which have been dead for some days.

Study of Contraction of Living Muscular Fibres.‡—M. L. Ranvier studied the appearances of living striated muscular fibres during stimulation by an electric current in the following manner:—The retro-lingual membrane of the frog is stretched over the platinum ring devised by the author, and placed in some indifferent fluid in a moist chamber. Before putting on the cover-glass and closing it down with paraffin, two strips of tinfoil are placed on the slide in such a way that they may serve as electrodes. These movable electrodes receive the current from a bichromate battery, the ends of the wires of which are surrounded by flat lumps of lead. These rest on the tinfoil.

Observations carried out in this way show that when a striated muscular fibre is stimulated, the striation is present during all stages of contraction, and that the contractility of muscle is invariably associated with the contraction of the thick discs, which assume a somewhat spheroidal shape, the thin discs on the clear spaces being unaffected.

In a similar way the contraction of unstriped muscular fibre is observed.

* Zool. Jahrb., iv. (Abth. f. Anat. u. Ontog.) pp. 420–1.

† Virchow's Archiv, cxix. (1890) pp. 385–98. See Zeitschr. f. Wiss. Mikr., vii. (1890) p. 364.

‡ Comptes Rendus, cx. (1890) pp. 613–7 (2 figs.).

And for this purpose the mesentery of *Triton cristatus* is recommended. The smooth fibre requires a greater stimulus than the striated muscle. The difference between the contraction of the two varieties of muscle is merely one of manner and not of kind; the striated muscle contracts quickly, the unstriped slowly.

Examining the Endbulbs of the Frog.*—M. J. Fajerstajn demonstrates the termination of the nerves in the tongue and palate of the frog as follows.

The fixatives used were chromic acid 1 to 400, sublimate 5 to 100, Kleinenberg's solution, Flemming's chrom-osmium-acetic acid, and Carnoy's fluid (alcohol 6 vols., glacial acetic acid 1 vol., chloroform 3 vols.). The sublimate and Flemming's and Carnoy's fluids were the best. The preparations were hardened in alcohol, and imbedded in celloidin or paraffin.

For isolating the cylinder-cells the following method gave the best results: a mixture of 4 per cent. bichromate of potash and 1 per cent. chloral hydrate is made, and in it is placed either a piece of the palate mucosa, or the whole tongue, for 12 to 60 hours. The preparation is then placed under a dissecting Microscope, and teased out in a very weak solution of iodine-green.

For staining sections, several procedures were followed, e. g. sublimate 5 per cent., alcohol, paraffin, alum-carmine, with acetic acid and anilin-blue; or Flemming's mixture, alcohol, paraffin, methyl-green, metanil-yellow or the latter, preceded by safranin, Carnoy's fluid, alcohol, paraffin, dahlia.

Methylen-blue was used very satisfactorily for demonstrating the course of nerves. For this purpose it is advised to inject through the abdominal veins, as thereby the circulation is least interfered with. The injection must be done slowly, after paralysing with curara or anæsthetizing with ether. The solution used by the author was 1 part methylen-blue to 800 parts of a 0·6 per cent. chloride of soda solution.

Preparing Retrolingual Membrane of the Frog to show the junction of Muscular and Elastic Elements, and the natural termination of Muscle Fibre.†—M. L. Ranvier was enabled to demonstrate the connection between the elastic and the muscular elements of the retrolingual membrane in frogs by the following method. It was thereby found that the elastic fibres are attached to the sarcolemma, the two structures being welded together so intimately that mechanical means fail to break the continuity.

The membrane taken from a pithed or decapitated frog is placed for 24 to 48 hours in one-third alcohol. The epi- and endothelia are then removed with a brush; after this the membrane is immersed for 24 hours in a weak solution of methyl-violet, 5B. The preparation is again washed and then mounted and examined in glycerin.

Another histological problem was also resolved from this membrane. What is the natural termination of a muscular fibre? Does it end in a thick disc, a thin disc, or in a clear space? By means of the following

* Arch. de Zool. Expér. et Gén., vii. (1889) pp. 705–50 (1 pl.). See Zeitschr. f. Wiss. Mikr., vii. (1890) pp. 357 9. † Comptes Rendus, cx. (1890) pp. 504–8.

method, the author demonstrated that the ending was in the thick disc. A frog is curarized. The lymphatic sacs are injected to distension with 2 per cent. bichromate of potash or ammonia. Eight or ten days afterwards, the retrolingual membrane is detached, and placed in water until it is decolorized. The epithelium is removed with a brush, and the preparation then stained with fresh hæmatoxylin and alcoholic eosin. The membrane is then dehydrated in alcohol, cleared up in oil of cloves, and mounted in balsam. Thus prepared, the thick discs are stained a bright red, the thin discs present a yellowish-rose colour, while the clear spaces are absolutely uncoloured.

In this way the succession of discs and clear spaces is easily followed right up into the tendon, where the muscle is seen to end as a rose-coloured hemispherical mass, which seems to correspond with a thick disc.

Hence, the author concludes that muscle fibrillæ end at the thick disc.

Examining the histolytic phenomena occurring in the tail of Batrachian Larvæ.*—For paralysing batrachian larvæ, Herr A. Looss prefers the use of an electric current (see this Journal, 1886, p. 700) to curara solutions, or to the pressure of a cover-glass. This method does not affect the histolytic processes which are taking place in the tail of the larva, and the only impediment to observation is the increasing pigmentation. The best fixative was found to be a mixture of sublimate and acetic acid (saturated aqueous solution of sublimate 150 ccm., distilled water 150 ccm., acetic acid 3–4 ccm.). After long washing in water, and having been tested with iodine alcohol to detect any remains of sublimate, the preparations are carefully hardened. For this, Fol's modification of Flemming's chrom-osmium acetic acid is recommended, but Müller's fluid, chromic acid, picric acid, and the mixture of chromic acid and platinum chloride are condemned. Staining was done in toto, in order to avoid damaging the preparation. Picrocarmine gave the best results, but acid-borax, alum and indigo-carmine, hæmatoxylin and anilin dyes were also employed. The paraffin imbedded sections (0·01 to 0·0075 mm. thick) were stuck on with glycerin albumen, and finally mounted in balsam.

For examining the so-called sarcolytes, decomposition-derivatives of striated muscle, Paneth's method was used. This consists in overstaining with picrocarmine, and then, after extraction of the excess of pigment, with hæmatoxylin and then dehydrating. After the sections have been freed from paraffin and stuck on the slide, they are washed with undiluted alcohol (96 per cent. spirit and 2·5 to 3 per cent. HCl). This leaves the hæmatoxylin only in the nucleus, and after thoroughly washing with slightly ammoniacal spirit, in order to remove all trace of acid, the nuclei are seen clearly defined, of a pure blue colour, and lying in a more or less red mass of protoplasm.

Examining the Blood for the Hæmatozoon of Malaria.†—M. Laveran states that the best time for examining malarious blood is

* Preisschr. d. Fürstl. Jablonowski'schen Gesellschaft zu Leipzig . . . d. Math.-Naturw. Section, 1889, 116 pp. and 4 pls. See Zeitschr. f. Wiss. Mikr., vii. (1890) pp. 352–4.

† La Semaine Méd., x. (1890) No. 53. See Centralbl. f. Bakteriol. u. Parasitenk., ix. (1890) pp. 15–6.

during the height of the paroxysm, and the patient should not have taken any quinine for some time. The tip of the finger, having been properly cleaned, is pricked with a lancet, and the drop of blood is then placed between two cover-glasses. Fresh blood is best examined by daylight and with high dry powers. The flagella will be seen most frequently on the edges of the pigmented round free corpuscles. If a dry preparation is to be examined, the cover-glasses are drawn apart, the blood allowed to dry, and then the cover-glass is drawn thrice through the flame.

The preparations may be examined unstained, but the author prefers to stain with a saturated aqueous solution of methylen-blue, before using which the cover-glass must be washed with equal parts of alcohol and ether. In this way the nuclei of the white corpuscles are stained dark blue, while the round bodies, either free or adhering to the red corpuscles, are pale blue, and the growing corpuscles scarcely at all coloured.

Hydroxylamin as a Paralysing Agent, or Prefixative, for small animals.*—Dr. B. Hofer recommends hydroxylamin for paralysing small animals, as this substance and its hydrochlorate or sulphate possess a well marked paralysing action on contractile elements.

In commerce it is obtained as the crystalline hydrochlorate; of this a 1 per cent. solution in water is made, and this is then rendered neutral by the addition of carbonate of soda. For dissolving the salt, spring, pond, or sea water must be used, and not distilled water. It is not advisable to have excess of the carbonate of soda, as this renders the solution too strongly basic and also less stable.

The animals having been palsied in this neutral solution of hydroxylamin, the next step is to fix them: for this purpose alcohol, picric and acetic acid, or a mixture of these acids, are recommended, as osmic and chromic acid, sublimate, the chlorides of gold and platinum are too easily reduced. The author gives several special examples of the action of this fluid. It is sufficient to state that it is used in 0·1 to 1 per cent. solution, the most useful strength being 0·25 per cent. From the examples quoted, e. g. *Stentor cæruleus*, *Spirostomum teres*, *Carchesium polypinum*, *Hydra grisea*, *Bunodes gemmacea*, *Dendrocœlum lacteum*, *Hirudo medicinalis*, Rotatoria and Mollusca, it is obvious that this reagent possesses a specific paralysing action on the contractile elements of the lower animals, and that its use as a preliminary to the permanent fixative is a distinct advantage. The length of time needed to produce the paralysing action of course varies with the size of the animal and the strength of the solution.

Preparation of Aleurone-grains.†—M. V. A. Poulsen calls attention to Overton's method of preparing and fixing the aleurone-grains in the endosperm of *Ricinus*. By plunging an absolute alcohol section in an aqueous solution of gallo-tannic acid, crystalloids are made to imbibe the acid and take a brown colour; they are then placed in a 1 per cent. solution of osmic acid, washed in distilled water, and preserved in glycerin. This method depends on the production of metallic osmium

* Zeitschr. f. Wiss. Mikr., vii. (1890) pp. 318–26.
† Rev. Gén. de Bot. (Bonnier), ii. (1890) pp. 547–8.

in the crystalloids. M. Poulsen recommends also the two following processes:—

(1) Very thin sections of the endosperm are first placed in absolute alcohol for twenty-four hours, and, as soon as they are hard, transferred for an hour to a 25 per cent. aqueous solution of tannic acid, and then washed with distilled water. They are then plunged in an aqueous solution of potassium bichromate until they become brown or yellow. The sections thus made are preserved in glycerin, and show the transparent aleurone-grains with great clearness.

(2) After being hardened as before, the sections are made to imbibe tannin and washed; they are then placed for an hour or less in a 10–20 per cent. aqueous solution of iron sulphate, which brings out a very dark-blue or almost black colour. The sections are then washed and dehydrated in absolute alcohol; and the preparations thus made are placed first of all in essence of clove, and finally in Canada balsam. They are beautifully clear, and very durable.

Reference Tables for Microscopical Work.*—The following continues Prof. A. B. Aubert's reference tables:†—

Gum with chloral hydrate:—Gum arabic, chloral hydrate, water. A cylinder, 60 ccm. contents, is filled two-thirds with gum arabic in pieces; to this is added a solution of chloral hydrate (several per cent.) containing 5–10 per cent. of glycerin; shake often; in a few days the gum will dissolve; the syrupy liquid is filtered. Carmine and hæmatoxylin stained objects can be mounted in this medium.

Gum and acetate of potash or of ammonia:—Gum arabic, acetate of potash or of ammonia, glycerin, water. Made as the preceding medium, only a solution of potassic or ammonic acetate is used instead of a solution of chloral. Anilin-stained objects can be mounted in this.

Iodized serum, artificial (Ranvier):—(1) distilled water, 135 grm.; (2) egg albumen, 15 grm.; (3) common salt, 0·2 grm.; (4) tincture of iodine, 3 grm. Mix 1, 2, and 3, and filter; add 4, and filter again. Used for examinations, not for mounting.

Potassio-mercuric iodide (Stephenson):—Biniodide of mercury, iodide of potassium, water. To the water add an excess of each salt, and filter. This gives a very dense liquid of high refractive index (3·02). For diatoms, &c., may be used diluted.

Monobromide of naphthalin.—High refractive index; for diatoms, &c.

Monobromide balsam:—Solution of hardened Canada balsam in monobromide of naphthalin. Refractive index high, 1·6; shows finer structure of diatoms, &c.

Monobromide tolu. Weir's medium:—Solution of balsam tolu in monobromide of naphthalin. Refractive index, 1·73; may prove very valuable as a medium for diatoms. *Preparation.*—Dissolve 3 oz. of balsam of tolu in 4 fluid drams of benzol, add 4 fluid oz. carbon disulphide; renew this treatment with more carbon disulphide; pour it off again; evaporate the benzol from the balsam tolu. The tolu will now be free from cinnamic acid; put 1 fluid dram of monobromide of naphthalin in 1/2 oz. vial; add enough of the purified tolu to make a stiff mixture or solution when cold. Heat to 104° or 122° F. when using.

* Microscope, xi. (1891) pp. 12–14.

† See *ante*, p. 142.

Pacini's solution:—Sodium chloride, 1 part; corrosive sublimate, 2 parts; water, 113 parts; glycerin, 13 parts. Let it stand three months, then use 1 part with 3 of water; filter before using. Recommended as a preservative of delicate tissues.

Phosphorus (Stephenson):—Concentrated solution in carbon disulphide. High refractive index; difficult and dangerous to use; takes fire spontaneously in the air.

Ripart's solution:—Camphor water, 75 parts; distilled water, 75 parts; glacial acetic acid, 1 part; copper acetate, 0·3 part; copper chloride, 0·3 part. Useful for delicate vegetable tissues, desmids, Confervæ, &c.

Styrax:—Chloroform solution. For diatoms; high refractive index.

American styrax:—Chloroform solution filtered and hardened, Colour as light as that of good balsam; high refractive index; for diatoms and fine tissues.

Harting's corrosive sublimate solution:—Corrosive sublimate, 1 part; water 200 to 500 parts. For blood-corpuscles, &c.

Williams' solution:—Saltpetre, 2 oz.; sal-ammoniac, 2 drams; corrosive sublimate, 1 dram; glycerin, 2 oz.; alcohol, 1 pint; water, 2 quarts. Let stand for several days; filter. More properly a preservative for large anatomical and other specimens.

Wickersheim's solution:—Alum, 100 grm.; saltpetre, 12 grm.; potash, 60 grm.; arsenious oxide, 20 grm.; boiled water, 3000 grm. A preservative of large anatomical and other specimens.

Virodtzeff's solution:—Glycerin, 2160 parts; water, 1080 parts; alcohol, 45 parts; thymol, 5 parts. A preservative of large anatomical and other specimens.

Use of Gelatin in fixing Museum Specimens.*—Herr E. Schmidt recommends the use of gelatin- instead of glass-plates as a basis on which to fix small animals for demonstration. The spirit-specimen is laid on a moistened portion of the gelatin-plate, and is fixed as the gelatin dries, or it is attached by silver thread. Herr E. Weltner describes how small and delicate specimens may be attached to glass plates by means of concentrated (aqueous) solution of fine French gelatin. The spirit-specimens are as far as possible dried from the involved alcohol, and then fixed by the gelatin on a warm glass plate. Sponges, Hydroids, Anthozoa, Ctenophores, Bryozoa, Tunicates, and such delicate animals as *Salpa*, *Ophrydium*, and *Collozoum*, are in this way successfully prepared. The gelatin solution must be concentrated, else it turns white when put into alcohol. For Medusæ and similar organisms, Weltner has adopted the glycerin and gelatin method recommended by List. Gelatin is dissolved in equal parts of glycerin and water; the cold mixture is again dissolved by boiling with about three times as much glycerin and water (again in equal parts); the almost cooled result is spread on a glass plate; on this the spirit-specimen with the alcohol dried off is then laid. A douche of absolute alcohol will hasten the fixing. The objection to the method seems to be that the cementing material turns white when the specimen is returned to alcohol. For the closure of glass vessels, Herr Weltner finds the use of gutta-percha most effective.

* SB. Gesell. Naturf. Freunde, 1890, pp. 95–8.

(3) Cutting, including Imbedding and Microtomes.

Strasser's Ribbon Microtome for Serial Sections.* — Prof. H. Strasser describes a microtome upon which he appears to have expended considerable pains in order to make the sections adhere to the under surface of a specially prepared roll of paper. Hence he calls it the "Schnitt-Aufklebe" microtome.

In the microtome proper there does not appear to be anything new,

FIG. 22.

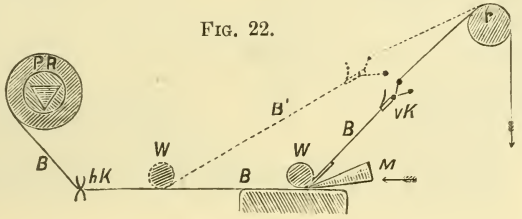
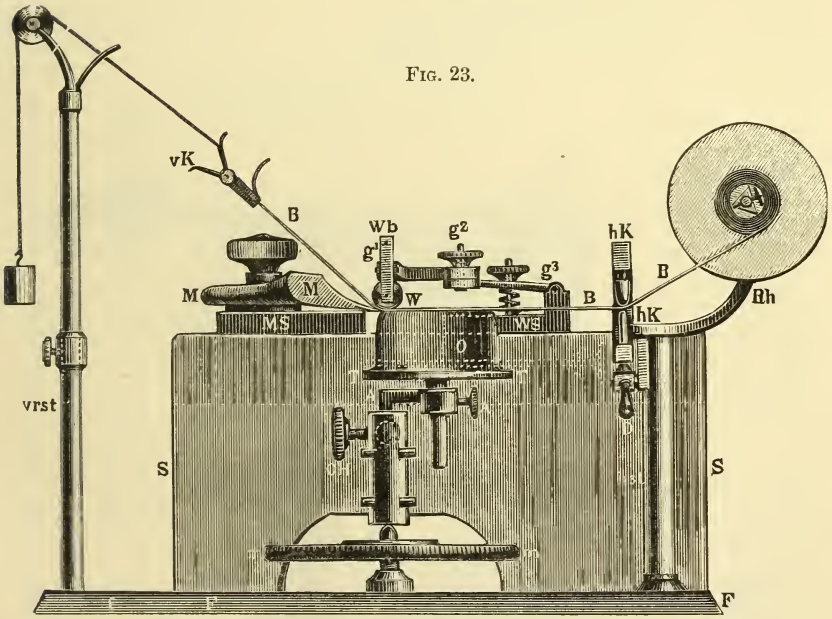


FIG. 23.



as it merely consists of the usual arrangements; that is, there is an object-holder raised by the micrometer-screw, and a knife-holder running on a heavy block in a V-shaped slide-way. The novel details consist in the apparatus for receiving the sections as they are cut off, and the

* Zeitschr. f. Wiss. Mikr., vii. (1890) pp. 289–304 (5 figs.).

Fig. 24.

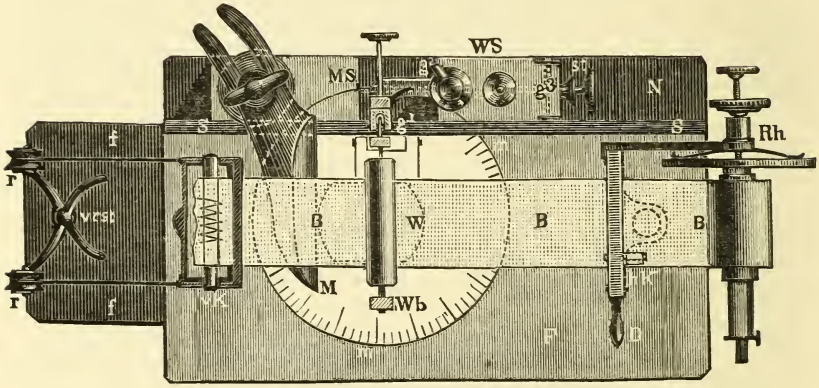
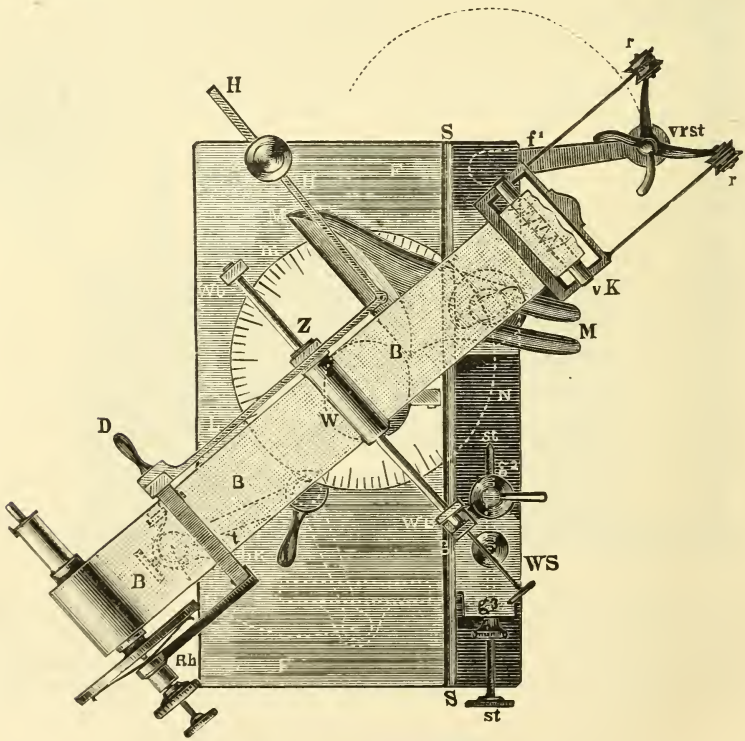
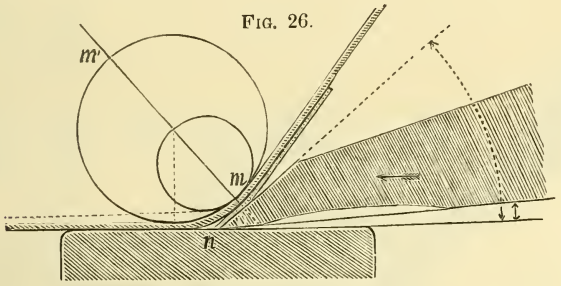


Fig. 25.



knife. The band arrangement is a roll of paper kept taut (figs. 22–25), and passing close to the edge of the knife. The roll P R passes first through a guiding loop *h* K, which gives it its direction parallel to the object. It is kept in this position, and at the same time applied to the edge of the knife M, by the roller W, the diameter of which is 8 mm. The band, after leaving the space between roller and knife-edge, is directed upwards to the clamp *v* K, and there passes over another roller *r*, and to its end is attached a weight for the purpose of keeping the whole quite taut (fig. 23). In order to reduce the friction between the knife, the roller, and the paper band to the practical minimum, the roller W is made as small as possible (8 mm.), and the upper surface of the knife-

FIG. 26.



edge is ground to an angle of 20°–25°. (See fig. 26.) The desired effect is thus obtained, and by using a paraffin of medium softness for imbedding the specimen, the sections show little tendency to break or curl up.

When in actual use, the paper band requires to be removed from the surface of the paraffin block in order to let the knife be put into position for cutting again. (See figs. 22 and 23.) This done, the roller is replaced, and receives after each alteration the necessary tension from a spring. As the sections are cut they adhere to the under-surface of the band. The adhesion is effected by smearing the block surface after every section with a mixture of castor oil 3 parts, and 1 part collodion of double strength. The microtome is made in two forms, as shown in figs. 23, 24, and 25.

In fig. 24 is seen a view from above of the simple construction for the cross position of the knife. In fig. 25 is a similar view of the more complicated apparatus, which allows the knife to be used in any position.

Miehe's Improved Lever Microtome.*—The lever microtome of Gustav Miehe, so called because the knife-carrier is fitted with a handle so that this piece may be easily worked, has been improved by the addition of a spring catch to the microtome screw-plate, so that every division of the plate, and therefore, of course, the rising or descent of the screw, is audibly clicked.

The mechanism of the recent addition is simple. It consists in a catch *m*, held in its place by the spring *n*, which is fitted on the end of an arm *o*, locking in the teeth of the microtome plate. As the pitch of the

* Preis-Verzeichniss von G. Miehe, 1889; Miehe's Catalogue of Microtomes.

microtome screw is 0·5 mm., and as there are 100 teeth on the edge of the plate, one turn equals 0·005 mm. If a section-thickness of 0·03 mm. be desired, the screw *l* is undone, and the circle segment *c* pushed back until the mark 3 corresponds with that on the vernier, after which it is tightened up. The handle *a* is then pushed from the upright *b* to the upright *d*. By this action the catch *m* pushes the micrometer

Fig. 27.

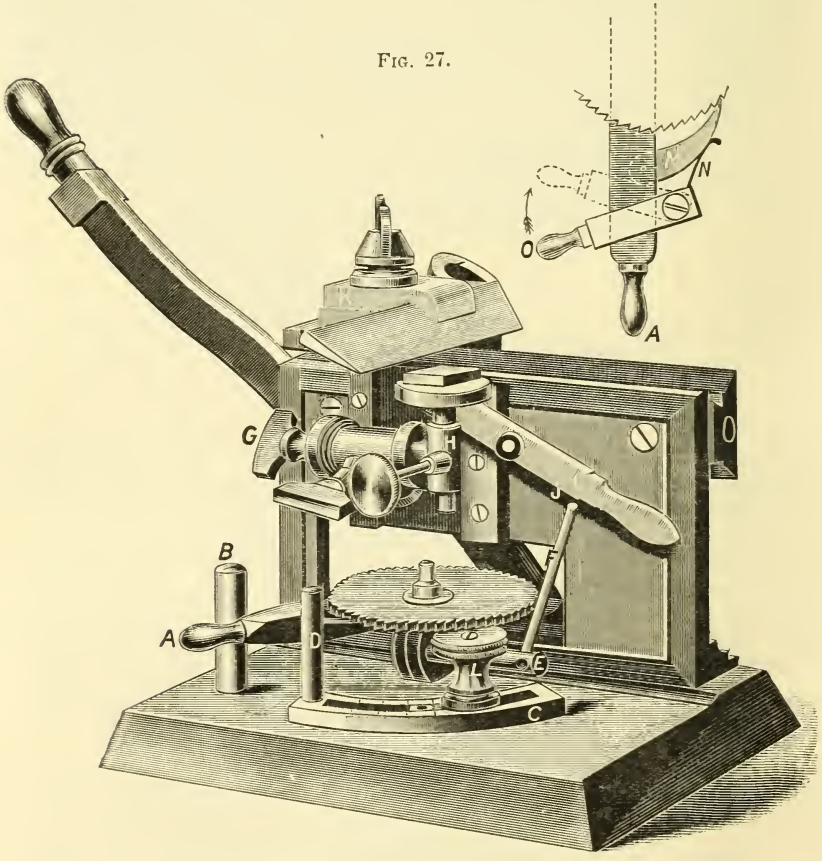


plate round, and the object-holder is thereby raised 0·03 mm. The handle is then pushed back again to *b* and the section made.

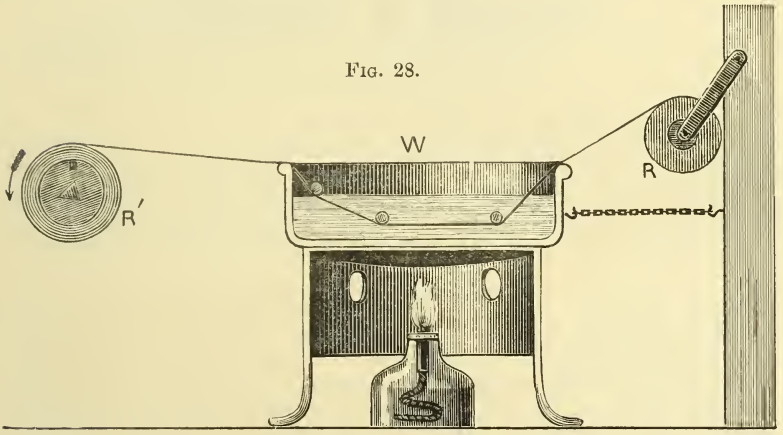
If the preparation has been raised too high, the object-holder is lowered in the following manner:—The screw *e* is unloosed by means of the rod *f*, and then the handle *o* is pushed in the direction of the arrow. This action sets free the catch *m*, so that the preparation-holder is easily lowered by screwing down the micrometer plate, and then pushing down the preparation-holder until its lowest part is in contact with

the uppermost part of the micrometer screw. The screw *e* is then tightened up.

With this instrument the knife may be used either in the cross or in the oblique position. The latter is shown in the illustration; the object-holder is moved to either position by means of the screw *g*.

Treatment and Manipulation of Paraffin-imbedded Sections.*— The principal advantage that celloidin possesses over paraffin is that it is more suitable for the manipulation of large sections. Prof. Strasser has laid himself out to devise means whereby this reproach may be

Fig. 28.



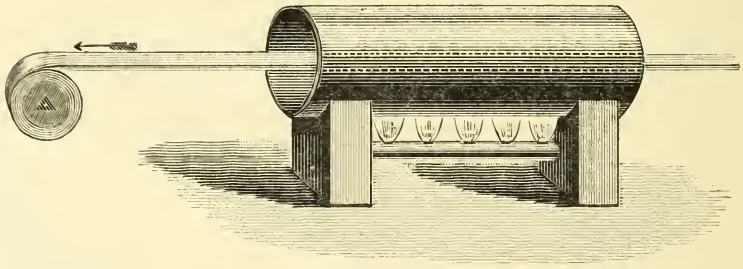
taken away from paraffin. This end may be attained by the adoption of the provisional slide (paper), by using a special form of microtome in which the sections are made to adhere to the provisional slide at the time of sectioning, and by leaving the sections on the provisional slide as long as possible. The provisional slide, which must necessarily be a roll of paper, is prepared either with wax or gum. In fig. 28 is shown the method of saturating the roll with Japanese wax. The illustration perfectly explains the method, and it is only necessary to point out that the roller R' is so far from the immersion tank that the wax is dry in the band before it reaches the roller. The rolls of gummed paper are made by passing the roll through a tank containing in solution gum arabic 50, glycerin 20, and water 100 parts, and then the band is dried by passing it through a tube heated underneath by a series of gas-jets (fig. 29).

The sections are then stuck on by means of an adhesive made of collodion and castor oil. This procedure is facilitated by the use of Strasser's "Schnitt-Aufklebe" microtome. After the bands or sections have been carefully numbered, they are covered with an adhesive composed of 2 parts collodion and 1 part castor oil, after which they are deposited in a turpentine bath, in order to dissolve the paraffin, and at

* Zeitschr. f. Wiss. Mikr., vii. (1890) pp. 304–17 (2 figs.).

the same time to harden the collodion. From this point we found it somewhat difficult to follow accurately the author's diffuse directions,

Fig. 29.



but it seems that the continuation of the procedure is as follows:—Immersion in pure benzin, then in 95 per cent. spirit, then in thick collodion. After this they are stained, and thereupon cleared up, first in 70–80 per cent. spirit, and finally in carbolxylol. The sections are in the end mounted definitely in balsam, or provisionally in paraffin.

(4) Staining and Injecting.

Metallic Impregnation of the Cornea.*—Prof. F. Tartuferi says that the fixed cells of the cornea, even to their most delicate prolongations, may be deeply stained by immersing the cornea of some adult animal (ox) in a solution of hyposulphite of soda (15 grm. to 100 of distilled water) for three days or longer, and keeping it at a temperature of about 26°. The preparation is then placed in a vessel containing finely powdered chloride of silver and a little pure water, for two days or longer.

If the adult cornea be treated in this manner for a still longer period, or if the cornea of a young animal be used, these fixed elements are but imperfectly visible, but other details are brought out, for example, numerous elastic fibrillæ; while by further variations of the foregoing method the isolated elastic fibrillæ of the cornea may be obtained. The preparations are quite permanent.

Staining Medullated Nerve-fibres with Hæmatoxylin and Carmine.†—Prof. N. Kultschitzky now gives more complete details of his method for staining sections of the central nervous system.‡ The material is hardened in Erlitzki's fluid for one or two months, and is then placed in running water for one or two days. It is next hardened in alcohol and imbedded in celloidin. The sections obtained in this way are stained with the hæmatoxylin solution (1 grm. hæmatoxylin dissolved in a small quantity of C_2H_6O and 100 grm. of 2 per cent. acetic acid). The staining is effected in from one to three hours. The sections are then placed in a mixture of 100 ccm. of saturated solution of lithium carbonate, and 10 ccm. of 1 per cent. solution of red prussiate of potash.

* Anat. Anzeig., v. (1890) pp. 524-6. † T. c., pp. 519-24.
‡ See this Journal, 1890, p. 115.

When sufficiently decolorized (two to three hours) the sections are thoroughly washed and then mounted in balsam.

For staining sections with carmine, the author uses a stain made as follows:—Powdered carmine is boiled for two to four hours in 10 per cent. acetic acid; for every 100 ccm. of acetic acid, 2 grm. of carmine are required. After cooling, the solution is filtered. In this acetic carmine the sections are immersed for twenty-four hours, after which they are decolorized in the lithium and prussiate of potash solution. As this is rapidly effected, the sections must be, at the proper moment, removed to distilled water and thoroughly washed therein, after which they are mounted in the usual manner.

Kultschitzky's Nerve-stain.*—Dr. J. Schaffer relates his experience of this method and his improvement thereon. This consisted in removing some of the stain from sections over-coloured in acetic-hæmatoxylin by means of borax-ferridcyanide of potassium solution. As to the previous preparation of the tissue by means of chromic acid, Erlicki's or Müller's fluid, Schaffer explains that the myelin of the medullary nerves has the strongest affinity for chromic acid and its salts, that in washing out there is a stage at which the chromic acid or salt has been removed from all the tissues except the medullary sheaths of the nerves, and that this is the moment for staining with hæmatoxylin.

Staining the Motor Nerve-cells of Torpedo.†—G. Magini, in studying the different positions of the caryoplasma and of the nucleolus in motor nerve-cells, obtained the best results in an examination of the electric lobes of the Torpedo by staining with Weigert's hæmatoxylin, after-staining with safranin, and then decolorizing with ferrocyanide of potash, and also by staining with methylen-blue in 1/10,000 KHO, and after-staining with safranin. The latter method produced especially fine preparations, the body of the cell being violet, the caryoplasma red, and the nucleolus blue.

Fixing and Staining Glands of Triton helveticus.‡—M. Heidenhain, in studying the histology of the cloaca and its glandular adnexa in the Triton, proceeded as follows:—Fixing was best done in picric acid or concentrated sublimate solution. For hardening, alcohol gradually increasing in strength until it became absolute. The specimens were stained with alum-carmine, and then treated with picric acid-alcohol, or aqueous solution of pure hæmatoxylin, and then mordanted with 1/2 to 1 per cent. alum solution.

When stained in sections stuck on with alcohol, or by Schällibaum's method, anilin dyes, acid fuchsin, methyl-green, orange were used, and these combinations with sublimate fixation produced excellent results.

Fixing, Staining, and Preserving the Cell-elements of Blood.§—Dr. H. Griesbach deals chiefly with the blood of Mollusca, although a few remarks are devoted to the blood-corpuscles of Vertebrata. As a fixative, the author has the highest opinion of the value of osmic acid.

* Anat. Anzeig., v. (1890) pp. 643–5.

† Atti R. Accad. dei Lincei Roma, vi. (1890) pp. 466–7 (2 figs.). See Zeitschr. f. Wiss. Mikr., vii. (1890) p. 356.

‡ Arch. f. Mikr. Anat., xxxv. (1890) pp. 173–274 (4 pls.). See Zeitschr. f. Wiss. Mikr., vii. (1890) pp. 356–7.

§ Zeitschr. f. Wiss. Mikr., vii. (1890) pp. 326–32.

The blood on the cover-glass may be exposed to the action of the vapour, or the acid (1 per cent. solution) may be mixed with it thereon, or it may be dropped into a watch-glass full of the acid. If the last method be adopted, the procedure may further be improved and simplified by mixing some pigment with it, so that the blood is at once stained and fixed. For this purpose the most useful dyes are methyl-green, methyl-violet, crystal violet, safranin, eosin, acid fuchsin, and rhodanin. In all cases a saturated aqueous solution of the pigment is mixed with a 1 per cent. solution of osmic acid.

For fixing and imparting a double stain good results were obtained from rhodanin and methyl-green. These pigments are to be dissolved separately and then added to the osmic acid. A blue-red fluid results, which stains the cell-body red and the nucleus green. Besides osmic acid, picrosulphuric acid, chrom-osmium-acetic acid, and gold chloride are favourably alluded to as fixatives.

For preserving specimens of fixed molluscan blood, resinous media are not suitable, the best material for the purpose being glycerin, which mixes easily with the before-mentioned fluids, and also keeps the colour fairly well. Permanent preparations are made by running a thin border to the cover-glass with some oil-colour (Cremser white), so as to prevent any pressure on the cell-elements, and also to keep the glycerin from exuding. Some glycerin is placed on the middle of the cover-glass, and to this is added the mixture of the blood and fixative and the whole carefully mixed. The cover-glass is then carefully laid upon a slide and ringed round.

Staining Terminations of Tracheæ and Nerves in Insect Wing Muscles by Golgi's Method.*—By the application of Golgi's method to the muscles of insects, Prof. S. R. Cajal obtained some unexpected results. It was found that the tracheæ in the feet and wings (the non-dissociable muscles) terminate in two horizontal networks, while in the dissociable muscles only one such network was demonstrable. The method also showed the termination of the nerves in the muscle-fibres as a system of delicate filaments, some of which were disposed upon and others beneath the sarcolemma. The technique is as follows:—Pieces 3–4 mm. thick are cut from the wing muscles and immersed for 12–24 hours in a mixture of osmic acid and potassium bichromate (1 per cent. osmic acid 5 parts, 3 per cent. bichromate of potash 20 parts). They are next placed for 24 hours in 0·75 per cent. nitrate of silver solution, after which they are treated with 40 per cent. alcohol. Thus prepared, the pieces are teased out and then again washed several times in spirit; after this they are cleared up in oil of cloves, passed through oil of turpentine, and then mounted in the usual way. For obtaining transverse sections, the muscle may be placed in elder-pith and so cut up, or it may be imbedded in paraffin and sectioned.

The black reaction in the tracheæ is always constant, but the staining of the nervous tissue is less certain, so that it is advisable to make a good number of preparations.

* Zeitschr. f. Wiss. Mikr., vii. (1890) pp. 332–42 (1 pl. and 3 figs.).

(5) Mounting, including Slides, Preservative Fluids, &c.

Can mounting media be improved for high powers by increasing the index of refraction?*—In answer to this question, Mr. J. D. Beck writes:—"It has been the aim of the microscopist to increase the refractive power of mounting media for diatoms, bacteria, biological and other specimens requiring a high amplification and the best resolution. Whether better results are attainable in this direction I am unable to say. All my diatoms, slides from J. D. Möller and others, are mounted dry or in balsam; I have never tried Prof. Smith's medium. If the increase in refraction is an improvement, would it not be a desideratum to attain still more satisfactory results, which perhaps might be accomplished by increasing the index of refraction of mounting media? The desideratum is to see what exists, and to secure for that the most favourable means, bearing in mind that we must not expect too much from the best lenses under unfavourable conditions or circumstances. A certain quack condemned my Beck's 1/6 in. objective because with it and a Beck's No. 2 ocular he could not see bacteria in spring water, when in fact the water, which was cold as ice, came out of a mountain of rocks so free of vegetable and organic matter that no organisms could live in it, while a drop of water from a rivulet showed thousands of bacteria under the same lens.

Insomuch as a large majority of microscopists cannot afford to buy the new Zeiss apochromatic objectives, they may perhaps increase the resolving or defining powers of the lenses of a cheap grade by improving the refractive properties of mounting media. While the philosophy of the Irishman, that "if a little is good, more is better," when he imbibed the second glass, may be rather extravagant in such cases, yet it may be solid philosophy for practical purposes in other directions; so then, may we not continue to experiment on media to increase the refractive power until we find still more satisfactory results?

A friend of mine copied and sent me a list of refractive indices. The highest index of fifty substances given is that of chromate of lead at 2·50 to 2·97. It would appear that all the salts of lead and zinc have a high index of refraction, which seems to be very much increased by the action of chromic acid, which probably exists in the metal chromium in a higher degree than in lead or zinc. I do not believe that nitre, which combines with chromium to form chromate of potassium, afterwards changed to bichromate of potassium through the action of sulphuric acid when exposed to acetate of lead, really increases the refraction of chromate of lead. I have my doubts whether the acetate of lead adds any refractive power to the bichromate of potassium. Native sulphur is given at 2·115, but when distilled with charcoal and reduced to a volatile spirit by adding one atom of carbon to two atoms of sulphur, forming bisulphide of carbon, the index is reduced from 2·115 to 1·678. This is what the carbon has done, and yet diamond, which is carbon crystallized, is way up to 2·47 to 2·75. I suppose it would be impossible to bleach and to reduce the chromate of lead to a colourless medium without destroying its high refraction. We might expose colourless linseed oil to the action of chromate of lead by heat,

* Microscope, x. (1891) pp. 18–20.

and when well settled filter a number of times, or clarify it as varnish is clarified. This would become a rapid drying medium *per se*. Resins might be treated with chromate of lead in the same manner. Whether this suggestion is practical I will leave for others to decide who have more experience and skill in chemistry than I.

What can be done with sulphur and phosphorus? Can we dissolve sulphur in oil and make a transparent medium of it?

There are phosphorus, 2·224; carbonate of lead, 1·866; oil of anise seed, 1·111; bisulphide of carbon, 1·678—all pretty high—what can be done with them? There may be other substances higher and better than those mentioned. How many will act in this important matter?"

Useful Mounting Menstruum.*—Dr. Alfred C. Stokes writes:—"In a recent number of 'Malpighia' M. Aser Poli called attention to the oil of cajeput as a valuable medium in which to place objects before their permanent mounting in Canada balsam, it being used as a clearing agent instead of the oil of cloves. He states that it is soluble in dilute alcohol, and thus permits of the direct transfer of the object to it, thereby avoiding the use of absolute alcohol. He also remarks that trials with the oil have been followed by beautiful results, the preparations being perfectly clear, and that delicate objects such as the marine Algæ, which are among the most difficult to preserve in a satisfactory way, are, when treated with the oil of cajeput, almost entirely free from the ordinary obnoxious shrinkage.

These qualities are all excellent ones, and by the microscopist that does but little work in mounting, the chance to simplify the operation should be hailed with joy. To do away with one of the processes that modern methods seem to consider necessary will be a boon. By the use of the oil of cajeput the worker can simplify his methods by discarding the absolute alcohol, and thus not only save himself considerable trouble and some time, but some expense, as an object cleared or soaked in oil of cloves cannot well be transferred from it to balsam without the intervention of absolute alcohol.

After having been cleared or soaked in the cajeput oil, the object may at once be mounted in the ordinary balsam, or in that dissolved in benzol or in chloroform. Absolute alcohol must be kept in a specially prepared bottle, as it evaporates rapidly and absorbs water greedily. To avoid its use is pleasant indeed.

Since reading M. Poli's account of the action of the oil I have been making a few experiments, and refer to them here in the hope that some that in their microscopical work have more need of mounting than I, will take the subject, continue the experiments, and report the results.

In my limited experience I have been pleased with the oil. It has a pleasantly aromatic odour and pale-green colour that are in no way objectionable.

Placed on a glass slip it evaporates, but not with such haste that the microscopist must hurry his movement to do as he would before it is gone; it evaporates somewhat slowly, and leaves no trace on the glass.

* Microscope, xi. (1891) pp. 4-6.

It is soluble in carbolic acid, or the commercial liquid acid as obtained of the druggist is soluble in it. With old benzol balsam that had become so hard and so nearly dry in the bottle that it had to be dug out with a knife in a stringy mass, the oil mixed perfectly, making the old material fluid and easily worked. What its action would be with benzol itself I can only infer from this experiment. In dilute alcohol it is, as M. Poli has said, perfectly soluble.

After evaporating Canada balsam to glassy hardness in the ordinary way before dissolving it in benzol or in chloroform, I dissolved it in the oil of cajeput, to learn what would be the result. This I found to be excellent. The hard balsam dissolves readily in the oil, and makes as thick or as thin a fluid as may be wanted. The solution, however, although readily effected, appears to take place with rather less facility than with benzol or chloroform. Still, it is accomplished by leaving the mixture to itself, the solution being made without attention on the part of the microscopist.

The results of mounting in the cajeput balsam justify all the good words that M. Poli has spoken of the oil as a clearing medium. After the object has been soaked in dilute alcohol for a convenient time, it is transferred to the oil of cajeput for as long as the microscopist may wish, and thence to the cajeput balsam in which it is to be mounted.

Under the cover-glass drying seems to be as rapid as with benzol balsam; the little that is unavoidably spread on the slip appears, however, to harden rather more slowly, yet I have made no comparative test. The effects of the mounting medium are excellent; as far as I can perceive, quite as good as those from benzol or chloroform balsam; and the simplifying of the process should be greatly in its favour with those that are not professional preparers, and are therefore not ready to give any amount of time and attention to their special work.

I have not tried it with staining fluids. This I must leave to others. M. Poli, however, in the note already referred to, says that objects treated with it, stained green and then mounted in Canada balsam, retain their colour. Further than that nothing is known about this part of the subject.

The reader will perceive that my experiments have been few and of little importance. I mention the matter only because I believe the menstruum will prove to be an exceedingly useful one, especially to the amateur, to whom the simplifying of the process and the avoidance of the use of absolute alcohol should certainly make it acceptable. The suggestion is not original with M. Poli, as the oil has been used by others and referred to in print, but has never come into general use as it should.

(6) Miscellaneous.

Desk for Microscopical Drawing.*—Dr. Giesenhagen has devised a desk or framework for microscopical drawing which is very easy to manage. The construction of the apparatus is easily understood

* Zeitschr. f. Wiss. Mikr., vii. (1890) pp. 169–72 (2 figs.).

from the accompanying illustrations. It is made of wood, and the drawing surface can be altered to and fixed in any desired position with ease. It is scarcely necessary to observe that it is intended for camera drawing.

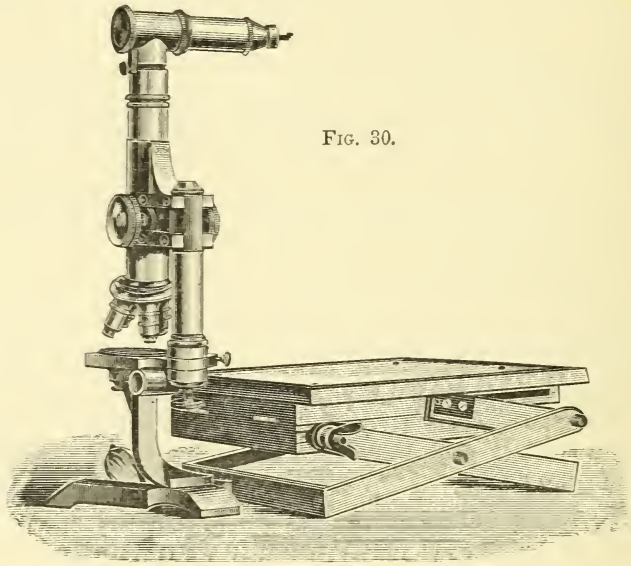


Fig. 30.

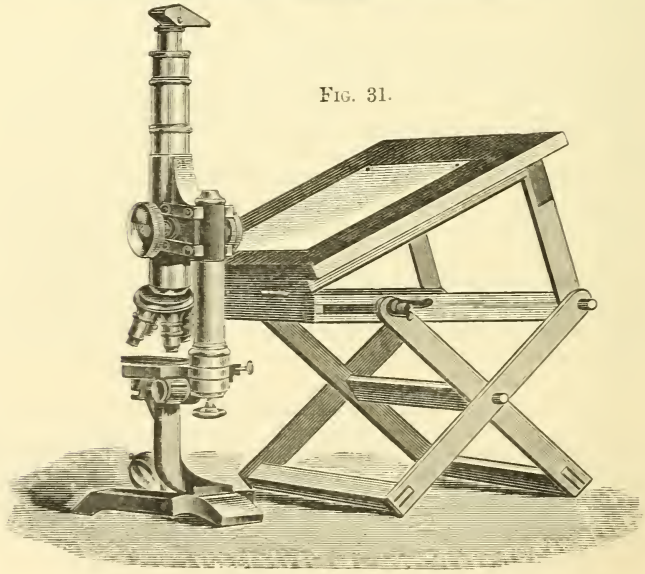


Fig. 31.

PROCEEDINGS OF THE SOCIETY.

Meeting of 18th February, 1891, at 20, Hanover Square, W., the President (Dr. R. Braithwaite, F.L.S.) in the Chair.

The Minutes of the meeting of 21st January last were read and confirmed, and were signed by the President.

The List of Donations (exclusive of exchanges and reprints) received since the last meeting was submitted, and the thanks of the Society given to the donors.

	From
Micrometer for recording the thickness of cover-glass, &c. ..	*Mr. E. Bausch.*
Slides (6) of Recent and Fossil Diatoms	*Miss M. A. Booth.*
Photomicrographs (12)	*Mr. E. G. Love.*
do. (6)	*Mr. W. H. Walmsley.*

Mr. J. Mayall, junr., said that amongst the donations there was (1) a screw-micrometer, devised by Mr. Edward Bausch, of the Bausch and Lomb Optical Company, and sent to them for the purpose of illustrating a paper reprinted in the current number of the Journal, pp. 108–13. The instrument was intended to furnish a ready means of measuring the thickness of cover-glasses to the 1/1000 in. or the 1/100 mm. In addition to this, Mr. Bausch had also sought to make it applicable to the purpose of indicating at the same time the proper length of body-tube necessary to be used with various thicknesses of cover-glass so as to obtain the best results from the use of each of a series of five unadjustable objectives made by the company. The various data which the instrument was intended to record were printed on the cylindrical part of the drum connected with the micrometer screw. He thought, however, that the idea might be a little too ambitious, because it presupposed that there was an absolute uniformity in objectives of the same denomination, which in practice it would be hardly possible to attain. The idea was, no doubt, good, and the instrument was not only very prettily designed, but was—he was informed—very inexpensive. As illustrating a point which Mr. Bausch believed to be important in practical microscopy, the Society would feel greatly interested in being able to add this instrument to their collection. (2) They had received from Mr. Walmsley, successor to Messrs. Beck, in Philadelphia, some specimens of the photographs produced with a simple form of small photomicrographic camera, which were very clear and sharp. The idea of making photographs on such small plates was first brought out some years ago by a Dublin firm, who made a camera in the form of a little box to fit on the end of the draw-tube. Mr. Walmsley had improved on that by making his with a bellows body, fitting upon an adjustable pillar and stand. (3) Some photomicrographs had also been received from Columbia College, New York. They were chiefly of popular objects, and had been produced with considerable technical skill. The letter by which they were accompanied

was read. (4) Six slides of Diatomaceæ had been forwarded from America by Miss M. A. Booth—a Fellow of the Society. They were very neatly mounted, and were exhibited under Microscopes in the room. A letter from the donor was read.

Mr. Andrew Pringle's "Note on Photomicrographs exhibited at the Meeting of the Society in November last, and on Remarks made by Dr. Dallinger and Mr. Nelson," was read. Mr. Mayall said that the fact noted by Mr. Pringle as to the photographic image spreading laterally was a new observation to him. Perhaps Mr. Nelson would say whether he had observed effects such as those mentioned by Mr. Pringle (see *ante*, p. 264).

Mr. E. M. Nelson said he had not observed anything of the kind; but he thought if correct methods were adopted, the object would be correctly represented by the image projected on the prepared plate. The whole difference was made by using small cones of light so as to get density of image. Of course, in that way they could easily get effects of that kind: by shutting up the condenser, for instance, they could double the image.

Mr. Mayall read a translation of a note (see *ante*, p. 265) by M. Fayel, communicated to the Société Linnéenne de Normandie, of which he was president, suggesting a novel method of examining large opaque objects, which he termed "Photomicrography in Space." The plan proposed by M. Fayel was to direct a photographic lens to the object, and focus the image upon the ground glass of the camera; then he removed the ground glass, and viewed the aerial image with a compound Microscope. Mr. Mayall thought it was by no means an easy matter to adapt a compound Microscope so as to be readily movable for inspecting different portions of the aerial image. The compound Microscope when so employed acted merely as an erecting eye-piece, and he thought M. Fayel must be mistaken in suggesting that powerful objectives might thus be employed with advantage.

Mr. T. Charters White said "there was nothing new under the sun"; the description just given of the "new" method of examining large objects recalled to his mind a similar plan devised by the late Dr. J. Matthews for precisely the same purpose, and described and exhibited at the Quekett Club in February 1879, under the name of the Micromegascope. Dr. Matthews used to place the object upon the table and form an image of it by means of an ordinary low-power objective, fitted into the tube of the substage with the front uppermost. This was then looked at through the Microscope in the ordinary way, and for examining flowers and other large objects it was very effective.

Mr. E. M. Nelson said the plan seemed like going all round the bush to get at a very indifferent result, because if they used a 2 in. objective upon the Microscope, they could take in an angle of 30°; whereas the photographic lens had practically no angle at all. This lens acted as a telescope object-glass, and the Microscope was used to magnify and erect just like the terrestrial eye-piece of a telescope. Zeiss did the same thing, only very much more perfectly, with his A* lens, which not only gave a great amount of light, but enabled the effect to be

altered from that of a telescope down to that of a 4 in. objective. The other plan was simply ludicrous as turning the Microscope into a very indifferent telescope.

Mr. Mayall said the instrument described by Mr. Charters White was known in the last century as the "Megaloscope," and had been constructed by B. Martin, both as a dioptric instrument and as a catadioptric; in the latter case an ordinary short-focus Gregorian reflecting telescope was so arranged that the distance between the reflectors could be increased so as to enable moderately near objects to be seen magnified. The plan adopted by Dr. Matthews was simply to adjust a low-power Microscope objective or a Kellner eye-piece in the substage, which he directed towards the object, or to a plane mirror in which it was reflected, and then he viewed the aerial image with the compound Microscope above. The difference between Dr. Matthews's plan and that of B. Martin was principally in the employment of achromatic objectives, which he believed had been first used in this way by Charles Chevalier. Mr. Mayall quite agreed with Mr. Nelson that such an arrangement was a very inferior way of building up a telescope for viewing moderately near objects; though it should be remembered that the late Dr. Royston Pigott fully believed he had been able to resolve about the one-millionth of an inch by such an arrangement, the fallacy of which had been conclusively demonstrated by Prof. Abbe in the Journal of the Society. But M. Fayel's arrangement was not open to Mr. Nelson's criticism regarding the angle of aperture, which applied, of course, when the projecting lens—the object-glass of the megaloscope—was a Microscope objective of very small linear aperture. M. Fayel proposed to use as the object-glass of his megaloscope a photographic lens of which the *linear* aperture would doubtless be very much larger than that of any Microscope objective, and the linear aperture would be proportionately more effective when utilised telescopically. The linear aperture of Microscope objectives of even 4 in. or 5 in. focus was practically limited by the diameter of the Society screw to something less than an inch; but many photographic lenses had been constructed of 4 in. to 6 in. focus, with linear apertures of $2\frac{1}{2}$ in. to $3\frac{1}{2}$ in., and these might be employed in the manner suggested by M. Fayel more effectively than Microscope objectives, collecting very much more light. He (Mr. Mayall) did not suppose that M. Fayel proposed this method of observation to supersede the recognized employment of low powers on the Microscope, but rather to meet the case where objects were to be viewed which could not be conveniently examined with an ordinary Microscope.

Prof. Bell gave a résumé of a paper by Dr. W. B. Benham "On *Eminia equatorialis*, a new earthworm from Equatorial Africa," explaining that the specimen described had been found by Emin Pasha, and forwarded to the Natural History Museum, whence, by permission of Dr. Günther, it had been sent to Dr. Benham for examination. Unfortunately, it was the only specimen collected, and its small size and immature condition made it difficult to say exactly what position should be assigned to it. There seemed no doubt as to its being a new genus. Dr. Benham's paper, minutely detailing such observa-

tions as it had been possible to make, would be published *in extenso* in the Journal.

On the motion of the President, the thanks of the Society were given to Dr. Benham for his communication.

Prof. Bell said they had also received a paper from Mr. T. B. Rosseter "On the Cysticercus of *Tænia coronula* found in specimens of *Cypris*." Mr. Rosseter had from time to time written to him with regard to his observations, but so far they had not been complete, and he had suggested to him the direction which it was advisable for him to take in order to render them so. Mr. Rosseter for some time failed to make the observations suggested to him, but he had repeatedly visited the field in which was situated the pond which contained the *Cypris*, in the hope of discovering the object of his search amongst the fæces of the animals by which the place was frequented. On one fortunate occasion, however, he found amongst the evacuations of a duck a small whitish ball which turned out to be a mass of seventy or eighty tapeworms. By reference to the work of Dujardin, where eight forms were described, he was able to find that one very closely resembled those he had found, and he came to the conclusion that the cysticercus of the *Cypris* was that of *Tænia coronula*. Unfortunately for Mr. Rosseter, it happened that his observations had been anticipated by those of a Hungarian gentleman, Herr Al. Mrázek, a notice of which appears in the just issued number of the Society's Journal (pp. 45–6), and though this might be a matter for regret, he had at least the satisfaction of knowing that his opinion was confirmed. There seemed to be every probability that Mr. Rosseter was right in determining the species to be *coronula*, and they might reasonably suppose that, living in the same pond, the duck might eat the *Cypris*, and in this way the transference from one host to the other would be effected.

The President said that although it appeared that Mr. Rosseter had been anticipated, he thought they might compliment him upon the perseverance he had shown in following up the matter, and that the thanks of the Society were due to him for his communication.

Mr. Mayall said they had received a preliminary notice of an International Exhibition to be opened this year at Antwerp in connection with the 300th anniversary of the invention of the Microscope. It was intended to exhibit Microscopes of all kinds, from the earliest to the most modern, and to include apparatus of all kinds relating to microscopy. Invitations would, doubtless, be given to the possessors of interesting Microscopes, &c., to contribute to the success of the exhibition by the loan of them (see *ante*, p. 271).

The President said they would probably receive some further communication on the matter later on, and it would no doubt make a pleasant trip for any one who could go over to see what was exhibited at Antwerp.

The following Instruments, Objects, &c., were exhibited:—

Mr. E. Bausch:—Micrometer for recording the thickness of cover-glass, &c.

Miss M. A. Booth:—Recent and fossil Diatoms.

Mr. E. G. Love:—Photomicrographs.

Mr. T. B. Rosseter:—Slides of Cysticercus of *Tænia coronula* Duj., in illustration of his paper.

Mr. W. H. Walmsley:—Photomicrographs produced with his camera.

New Fellows:—The following were elected *Ordinary* Fellows:—Messrs. Horace T. Brown, F.R.S., A. Harrison, F.C.S., James E. Talmage, D.D., E. W. Weis, M.D., and William H. Southon. Prof. Hermann Fol and Prof. Sir Joseph Lister, Bt., F.R.S., were elected *Honorary* Fellows.

Meeting of 18th March, 1891, at 20, Hanover Square, W., the President (Dr. R. Braithwaite, F.L.S.) in the Chair.

The Minutes of the meeting of 18th February last were read and confirmed, and were signed by the President.

The List of Donations (exclusive of exchanges and reprints) received since the last meeting was submitted, and the thanks of the Society given to the donors.

	From
Brady, H. B., Report on the Foraminifera collected by H.M.S. "Challenger" during the years 1873–76. xxi. and 814 pp., Atlas of 115 pls. (4to, London, 1884)..	*Mr. E. W. Burgess.*
Pabst, C., 'Leitfaden der Theoretischen Optik zum Gebrauche auf höheren Unterrichtsanstalten und beim Selbstunterrichte.' vi. and 100 pp., 22 figs. (8vo, Halle a. S., 1888)..	*Mr. F. Crisp.*
Photographs (2) of *Lophopus crystallinus*	*Mr. J. B. Robinson.*

Letters from Prof. Hermann Fol, of Nice, and Prof. Sir Joseph Lister, Bt., F.R.S., expressing their thanks to the Society for the honour of their election as honorary Fellows, were read to the meeting.

Prof. Bell, in calling special attention to the two volumes presented by Mr. Burgess, remarked that they formed together one of the largest of the reports resulting from the "Challenger" Expedition, and considering the mass of material from which they had been compiled, and the manner in which the work had been done, they not only formed a monument to the memory of their late honorary Fellow, Mr. H. B. Brady, but would also be a most valuable addition to the Society's library.

Mr. Mayall said they had received a letter from a correspondent in America—Mr. J. H. Noblit—asking for information as to working with high powers on opaque objects. He hoped some Fellow who had experience in such matters would undertake to reply to this communi-

cation. A letter had also been received from Col. O'Hara, dealing with sundry points connected with photomicrography.

Mr. E. M. Nelson exhibited and described a new design of student's Microscope recently brought out by Mr. Baker, the idea of which was to provide a Microscope of this class fitted with some of the more important accessories usually only supplied to instruments of an expensive character. The one now shown was fitted with all the ordinary movements. It had a good coarse-adjustment, a differential fine-adjustment, a centering substage with rackwork, and a Wright's finder. The stage was of the horseshoe shape, and solid and well made, so that the instrument answered to the description given of it as a cheap Microscope capable of doing all ordinary microscopic work. The production of instruments of this class was a matter in which he had always taken great interest, and he had done what he could of late years to promote their improvement. He believed also that he was the first to put a coarse-adjustment to them, in place of the sliding tube which at one time used to be thought good enough, because the common German Microscopes were made in that way. The cheaper way in which the differential fine-adjustment was now made enabled this also to be introduced without exceeding a reasonable price. He thought Mr. Baker had risen to the times in bringing out this instrument, and deserved great credit for so doing, because English makers generally had not studied to meet the real requirements of students, but had been content to copy inferior Continental models. The consequence was that our schools and colleges were flooded with cheap German Microscopes, and people who went to study at German universities came back with the idea that what was in use there was the best thing of its kind for the purpose for which it was wanted.

Mr. Karop said that he also had advocated for a long time this kind of improvement in the cheaper forms of Microscope, and was therefore very glad to see such a successful attempt made in this direction. There was one thing, however, which he thought required attention, and that was the draw-tube, which was not long enough for use with the higher power English objectives as adjusted to the ordinary English body length; it seemed to want a supplementary draw-tube, like that which was shown by Mr. Nelson at a recent meeting of the Society. The finder would be found a very useful addition to what seemed likely to prove a very useful form of instrument.

Mr. Mayall said this Microscope represented the second serious effort recently made to meet the want of a good, cheap student's Microscope, the first having been made by Mr. Swift, and described some time since by Mr. Karop. In the instrument before them, it seemed to be rather a mistake to make it with such a low base, as there was now scarcely height enough to get at the substage or mirror; a little more room for the hands below the stage would, he thought, be advantageous. The possession of the centering substage would, he need hardly point out, be of great advantage.

The President thought that a greater elevation of the stage would also be an improvement.

Mr. Nelson quite agreed with Mr. Mayall's suggestion as to the

desirability of greater height of the base; but then there was a veto against it being made otherwise. The German Microscopes were made of a certain height, and, of course, the English ones must be made the same!

Mr. T. Charters White read his paper "On a new Method of demonstrating Cavities in Dental and Osseous Tissues," which was illustrated by specimens exhibited under the Microscopes in the room.

The President said the Society was much obliged to Mr. White for his paper; certainly his specimens bore out his remarks, and they were most beautifully shown.

Mr. E. M. Nelson exhibted an enlargement of a photomicrograph. He did not approve of that kind of thing; but, as it was done on the Continent, perhaps, if nothing of the kind was produced in England, it might be said that they were unable to make enlargements.

Mr. E. M. Nelson read his paper "On the Optical Principles of Microscope Bull's-eyes," illustrating the subject by drawings on the blackboard.

The President thanked Mr. Nelson for the practical way in which he had dealt with a subject of great importance to all who worked with the Microscope.

Dr. Dallinger said that the remarks and details which had been laid before them by Mr. Nelson might have seemed to be dry and hard; but in reality they were of the most practically useful kind which could be brought under the notice of such a society as theirs. He had not only pointed out defects in optical construction, but also the way in which those defects might be corrected. All who worked much with the Microscope were aware that it was a matter of the utmost importance to get a condenser as far as possible aplanatic, not merely upon the grounds mentioned by Mr. Nelson, but because a condenser so constructed was of the greatest importance in order to bring out the best results of an aplanatic objective. He was very glad, therefore, to find that Mr. Nelson had brought his practical mind to bear upon the subject, and that he had not only shown them the defects of existing forms, but had put into the hands of opticians the means by which those defects might be corrected.

Mr. Mayall thought that, for the honour of their theoretical opticians, it should be mentioned that the theory as to the passage of the rays of light through lenses was dealt with by Herschel in his well-known treatise on light in the 'Encyclopædia Metropolitana,' and in Coddington's 'Treatise on the Reflexion and Refraction of Light' (1829–30) it was gone into in a most complete manner, and the transmission of rays in the case of the meniscus, and every other form of non-achromatic lens, was exhaustively dealt with. This treatise of Coddington's should not be confused with the two editions of his work on 'Optics,' published earlier. The later treatise embodied some of the then most recent investigations in optics by Airy, Herschel, and others, and was still regarded as one of the most important textbooks on the subject. The formula for aplanatic foci, to which Mr. Nelson had referred, was generally assigned to Lagrange. Gauss and Listing had

contributed most important general theorems, whence the passage of rays of light through systems of lenses could be determined. In the current number of the Society's Journal was a translation of a paper by the late Prof. G. Govi, in which that distinguished physicist endeavoured to still further simplify computations of that kind. He mentioned these facts because Mr. Nelson seemed rather to suppose the theory had not received the attention it merited, inasmuch as Heath's recently published work on optics dealt with it only partially. He (Mr. Mayall) thought English publishers of scientific works had hitherto been very remiss in not supplying English students with translations of the best German and French works on optics. Gauss's works were still for the most part unknown in England, as also were Listing's. Mr. Adolphe Martin's application of Gauss's theories to optical instruments, and M. Croullebois's development of them in connection with lenses of given thicknesses, ought to appear in English. There was also Verdet's 'Optique Physique,' and many other optical works of great importance, which were, of course, known to professional mathematicians in England; but they were hardly referred to in the textbooks in general use.

Mr. Mayall said that since the last meeting he had received another notification from the authorities of the Antwerp Microscopical Exhibition, giving further details than those which he was able to communicate at the last meeting of the Society. From this it appeared that the exhibition was to be open during August and September next, and the proposed mode of classification was given (see *ante*, p. 271.) It was clear the exhibition was intended to be pretty exhaustive, and if in each class there was only a moderate representation, the whole would be likely to form a very interesting collection.

Prof. Bell said they had also received from the General Secretary of the International Congress on Hygiene, to be held in London in August next, an invitation to appoint delegates to represent the Society at the meetings, and thinking it very desirable that they should be so represented, the Council had requested the President and Dr. Dallinger to undertake the duty. This congress, he might mention, was the seventh of a series which had been held in all the great capitals of Europe except Great Britain, and it was expected that the forthcoming gathering would be one of the most important yet held.

The President announced that arrangements had been made to hold an exhibition meeting and conversazione of the Fellows of the Society on the evening of Thursday, April 30th.

The following Instruments, Objects, &c., were exhibited:—

Mr. C. Baker:—Baker's Improved Student's Microscope.

Mr. J. B. Robinson;—Photographs of *Lophopus crystallinus*.

Mr. C. Rousselet:—*Hydra tuba*, Medusa stage.

Mr. T. Charters White:—Infiltrated sections of Bone and Dentine.

New Fellows.—The following were elected *Ordinary* Fellows:—Messrs. Kay Lees, F.R.C.V.S., Alfred B. Loder, J.P., and Colonel Alexander Ewing.

The Journal is issued on the third Wednesday of
February, April, June, August, October, and December.

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JOURNAL

OF THE

ROYAL MICROSCOPICAL SOCIETY;

CONTAINING ITS TRANSACTIONS AND PROCEEDINGS,

AND A SUMMARY OF CURRENT RESEARCHES RELATING TO

ZOOLOGY AND BOTANY

(principally Invertebrata and Cryptogamia),

MICROSCOPY, &c.

Edited by

F. JEFFREY BELL, M.A.,

One of the Secretaries of the Society
and Professor of Comparative Anatomy and Zoology in King's College;

WITH THE ASSISTANCE OF THE PUBLICATION COMMITTEE AND

A. W. BENNETT, M.A., B.Sc., F.L.S., *Lecturer on Botany at St. Thomas's Hospital,*
JOHN MAYALL, JUN., F.Z.S.,
R. G. HEBB, M.A., M.D. (*Cantab.*),

AND

J. ARTHUR THOMSON, M.A.,
Lecturer on Zoology in the School of Medicine, Edinburgh,
FELLOWS OF THE SOCIETY.

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δ. Lamellibranchiata.

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Arthropoda.

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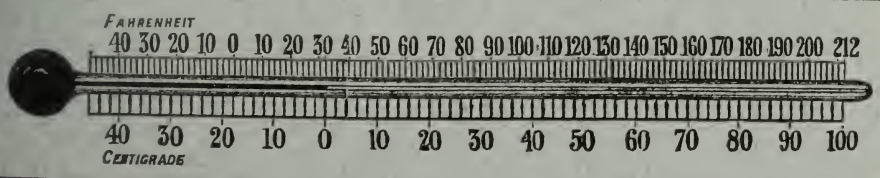
APERTURE TABLE.

Numerical Aperture. ($n \sin u = a$.)	Corresponding Angle ($2u$) for			Limit of Resolving Power, in Lines to an Inch.			Illuminating Power. (a^2.)	Penetrating Power $\left(\frac{1}{a}\right)$
	Air ($n = 1{\cdot}00$).	*Water* ($n = 1{\cdot}33$).	*Homogeneous Immersion* ($n = 1{\cdot}52$).	White Light. ($\lambda = 0{\cdot}5269\ \mu$, Line E.)	Monochromatic (Blue) Light. ($\lambda = 0{\cdot}4861\ \mu$, Line F.)	Photography. ($\lambda = 0{\cdot}4000\ \mu$, near Line h.)		
1·52	..	..	180° 0′	146,543	158,845	193,037	2·310	·658
1·51	..	..	166° 51′	145,579	157,800	191,767	2·280	·662
1·50	..	..	161° 23′	144,615	156,755	190,497	2·250	·667
1·49	..	..	157° 12′	143,651	155,710	189,227	2·220	·671
1·48	..	..	153° 39′	142,687	154,665	187,957	2·190	·676
1·47	..	..	150° 32′	141,723	153,620	186,687	2·161	·680
1·46	..	..	147° 42′	140,759	152,575	185,417	2·132	·685
1·45	..	..	145° 6′	139,795	151,530	184,147	2·103	·690
1·44	..	..	142° 39′	138,830	150,485	182,877	2·074	·694
1·43	..	..	140° 22′	137,866	149,440	181,607	2·045	·694
1·42	..	..	138° 12′	136,902	148,395	180,337	2·016	·709
1·41	..	..	136° 8′	135,938	147,350	179,067	1·988	·709
1·40	..	..	134° 10′	134,974	146,305	177,797	1·960	·714
1·39	..	..	132° 16′	134,010	145,260	176,527	1·932	·719
1·38	..	..	130° 26′	133,046	144,215	175,257	1·904	·725
1·37	..	..	128° 40′	132,082	143,170	173,987	1·877	·729
1·36	..	..	126° 58′	131,118	142,125	172,717	1·850	·735
1·35	..	..	125° 18′	130,154	141,080	171,447	1·823	·741
1·34	..	..	123° 40′	129,189	140,035	170,177	1·796	·746
1·33	..	180° 0′	122° 6′	128,225	138,989	168,907	1·769	·752
1·32	..	165° 56′	120° 33′	127,261	137,944	167,637	1·742	·758
1·30	..	155° 38′	117° 35′	125,333	135,854	165,097	1·690	·769
1·28	..	148° 42′	114° 44′	123,405	133,764	162,557	1·638	·781
1·26	..	142° 39′	111° 59′	121,477	131,674	160,017	1·588	·794
1·24	..	137° 36′	109° 20′	119,548	129,584	157,477	1·538	·806
1·22	..	133° 4′	106° 45′	117,620	127,494	154,937	1·488	·820
1·20	..	128° 55′	104° 15′	115,692	125,404	152,397	1·440	·833
1·18	..	125° 3′	101° 50′	113,764	123,314	149,857	1·392	·847
1·16	..	121° 26′	99° 29′	111,835	121,224	147,317	1·346	·862
1·14	..	118° 0′	97° 11′	109,907	119,134	144,777	1·300	·877
1·12	..	114° 44′	94° 55′	107,979	117,044	142,237	1·254	·893
1·10	..	111° 36′	92° 43′	106,051	114,954	139,698	1·210	·909
1·08	..	108° 36′	90° 34′	104,123	112,864	137,158	1·166	·926
1·06	..	105° 42′	88° 27′	102,195	110,774	134,618	1·124	·943
1·04	..	102° 53′	86° 21′	100,266	108,684	132,078	1·082	·962
1·02	..	100° 10′	84° 18′	98,333	106,593	129,538	1·040	·980
1·00	180° 0′	97° 31′	82° 17′	96,410	104,503	126,998	1·000	1·000
0·98	157° 2′	94° 56′	80° 17′	94,482	102,413	124,458	·960	1·020
0·96	147° 29′	92° 24′	78° 20′	92,554	100,323	121,918	·922	1·042
0·94	140° 6′	89° 56′	76° 24′	90,625	98,233	119,378	·884	1·064
0·92	133° 51′	87° 32′	74° 30′	88,697	96,143	116,838	·846	1·087
0·90	128° 19′	85° 10′	72° 36′	86,769	94,053	114,298	·810	1·111
0·88	123° 17′	82° 51′	70° 44′	84,841	91,963	111,758	·774	1·136
0·86	118° 38′	80° 34′	68° 54′	82,913	89,873	109,218	·740	1·163
0·84	114° 17′	78° 20′	67° 6′	80,984	87,783	106,678	·706	1·190
0·82	110° 10′	76° 8′	65° 18′	79,056	85,693	104,138	·672	1·220
0·80	106° 16′	73° 58′	63° 31′	77,128	83,603	101,598	·640	1·250
0·78	102° 31′	71° 49′	61° 45′	75,200	81,513	99,058	·608	1·282
0·76	98° 56′	69° 42′	60° 0′	73,272	79,423	96,518	·578	1·316
0·74	95° 28′	67° 37′	58° 16′	71,343	77,333	93,979	·548	1·351
0·72	92° 6′	65° 32′	56° 32′	69,415	75,242	91,439	·518	1·389
0·70	88° 51′	63° 31′	54° 50′	67,487	73,152	88,899	·490	1·429
0·68	85° 41′	61° 30′	53° 9′	65,559	71,062	86,359	·462	1·471
0·66	82° 36′	59° 30′	51° 28′	63,631	68,972	83,819	·436	1·515
0·64	79° 36′	57° 31′	49° 48′	61,702	66,882	81,279	·410	1·562
0·62	76° 38′	55° 34′	48° 9′	59,774	64,792	78,739	·384	1·613
0·60	73° 44′	53° 38′	46° 30′	57,846	62,702	76,199	·360	1·667
0·58	70° 54′	51° 42′	44° 51′	55,918	60,612	73,659	·336	1·724
0·56	68° 6′	49° 48′	43° 14′	53,990	58,522	71,119	·314	1·786
0·54	65° 22′	47° 54′	41° 37′	52,061	56,432	68,579	·292	1·852
0·52	62° 40′	46° 2′	40° 0′	50,133	54,342	66,039	·270	1·922
0·50	60° 0′	44° 10′	38° 24′	48,205	52,252	63,499	·250	2·000
0·45	53° 30′	39° 33′	34° 27′	43,385	47,026	57,149	·203	2·222
0·40	47° 9′	35° 0′	30° 31′	38,564	41,801	50,799	·160	2·500
0·35	40° 58′	30° 30′	26° 38′	33,744	36,576	44,449	·123	2·857
0·30	34° 56′	26° 4′	22° 46′	28,923	31,351	38,099	·090	3·333
0·25	28° 58′	21° 40′	18° 56′	24,103	26,126	31,749	·063	4·000
0·20	23° 4′	17° 18′	15° 7′	19,282	20,901	25,400	·040	5·000
0 15	17° 14′	12° 58′	11° 19′	14,462	15,676	19,050	·023	6·667
0·10	11° 29′	8° 38′	7° 34′	9,641	10,450	12,700	·010	10·000
0·05	5° 44′	4° 18′	3° 46′	4,821	5,225	6,350	·003	20·000

COMPARISON OF THE FAHRENHEIT AND CENTIGRADE THERMOMETERS.

Fahr.	Centigr.	Fahr.	Centigr.	Fahr.	Centigr.	Fahr.	Centigr.	Fahr.	Centigr.
°	°	°	°	°	°	°	°	°	°
212	100	158	70	104	40	50	10	- 4	- 20
210·2	99	156·2	69	102·2	39	48·2	9	- 5·8	- 21
210	98·89	156	68·89	102	38·89	48	8·89	- 6	- 21·11
208·4	98	154·4	68	100·4	38	46·4	8	- 7·6	- 22
208	97·78	154	67·78	100	37·78	46	7·78	- 8	- 22·22
206·6	97	152·6	67	98·6	37	44·6	7	- 9·4	- 23
206	96·67	152	66·67	98	36·67	44	6·67	- 10	- 23·33
204·8	96	150·8	66	96·8	36	42·8	6	- 11·2	- 24
204	95·56	150	65·56	96	35·56	42	5·56	- 12	- 24·44
203	95	149	65	95	35	41	5	- 13	- 25
202	94·44	148	64·44	94	34·44	40	4·44	- 14	- 25·56
201·2	94	147·2	64	93·2	34	39·2	4	- 14·8	- 26
200	93·33	146	63·33	92	33·33	38	3·33	- 16	- 26·67
199·4	93	145·4	63	91·4	33	37·4	3	- 16·6	- 27
198	92·22	144	62·22	90	32·22	36	2·22	- 18	- 27·78
197·6	92	143·6	62	89·6	32	35·6	2	- 18·4	- 28
196	91·11	142	61·11	88	31·11	34	1·11	- 20	- 28·89
195·8	91	141·8	61	87·8	31	33·8	1	- 20·2	- 29
194	90	140	60	86	30	32	0	- 22	- 30
192·2	89	138·2	59	84·2	29	30·2	- 1	- 23·8	- 31
192	88·89	138	58·89	84	28·89	30	- 1·11	- 24	- 31·11
190·4	88	136·4	58	82·4	28	28·4	- 2	- 25·6	- 32
190	87·78	136	57·78	82	27·78	28	- 2·22	- 26	- 32·22
188·6	87	134·6	57	80·6	27	26·6	- 3	- 27·4	- 33
188	86·67	134	56·67	80	26·67	26	- 3·33	- 28	- 33·33
186·8	86	132·8	56	78·8	26	24·8	- 4	- 29·2	- 34
186	85·56	132	55·56	78	25·56	24	- 4·44	- 30	- 34·44
185	85	131	55	77	25	23	- 5	- 31	- 35
184	84·44	130	54·44	76	24·44	22	- 5·56	- 32	- 35·56
183·2	84	129·2	54	75·2	24	21·2	- 6	- 32·8	- 36
182	83·33	128	53·33	74	23·33	20	- 6·67	- 34	- 36·67
181·4	83	127·4	53	73·4	23	19·4	- 7	- 34·6	- 37
180	82·22	126	52·22	72	22·22	18	- 7·78	- 36	- 37·78
179·6	82	125·6	52	71·6	22	17·6	- 8	- 36·4	- 38
178	81·11	124	51·11	70	21·11	16	- 8·89	- 38	- 38·89
177·8	81	123·8	51	69·8	21	15·8	- 9	- 38·2	- 39
176	80	122	50	68·2	20	14	- 10	- 40	- 40
174·2	79	120·2	49	66	19	12·2	- 11	- 41·80	- 41
174	78·89	120	48·89	66·4	18·89	12	- 11·11	- 42	- 41·11
172·4	78	118·4	48	64	18	10·4	- 12	- 43·60	- 42
172	77·78	118	47·78	64·6	17·78	10	- 12·22	- 44	- 42·22
170·6	77	116·6	47	62	17	8·6	- 13	- 45·40	- 43
170	76·67	116	46·67	62·8	16·67	8	- 13·33	- 46	- 43·33
168·8	76	114·8	46	60	16	6·8	- 14	- 47·20	- 44
168	75·56	114	45·56	60	15·56	6	- 14·44	- 48	- 44·44
167	75	113	45	59	15	5	- 15	- 49	- 45
166	74·44	112	44·44	58	14·44	4	- 15·56	- 50	- 45·56
165·2	74	111·2	44	57·2	14	3·2	- 16	- 50·80	- 46
164	73·33	110	43·33	56	13·33	2	- 16·67	- 52	- 46·67
163·4	73	109·4	43	55·4	13	1·4	- 17	- 52·60	- 47
162	72·22	108	42·22	54	12·22	0	- 17·78	- 54	- 47·78
161·6	72	107·6	42	53·6	12	- 0·4	- 18	- 54·40	- 48
160	71·11	106	41·11	52	11·11	- 2	- 18·89	- 56	- 48·89
159·8	71	105·8	41	51·8	11	- 2·2	- 19	- 56·20	- 49
								- 58	- 50



ROYAL MICROSCOPICAL SOCIETY.

MEETINGS FOR 1891, at 8 p.m.

Wednesday,	JANUARY	21	Wednesday,	MAY	20
	(Annual Meeting for Election of Officers and Council.)		„	JUNE	17
„	FEBRUARY	18	„	OCTOBER	21
„	MARCH	18	„	NOVEMBER	18
„	APRIL	15	„	DECEMBER	16

Fellows intending to exhibit any Instruments, Objects, &c., or to bring forward any Communication at the Ordinary Meetings, will much facilitate the arrangement of the business thereat if they will inform the Secretaries of their intention two clear days at least before the Meeting.

Authors of Papers printed in the Transactions are entitled to 20 copies of their communications *gratis*. Extra copies can be had at the price of 10*s*. 6*d*. per half-sheet of 8 pages, or less, including cover, for a minimum number of 50 copies, and 6*s*. per 100 plates, if plain. Prepayment by P.O.O. is requested.

JOURNAL

OF THE

ROYAL MICROSCOPICAL SOCIETY.

JUNE 1891.

TRANSACTIONS OF THE SOCIETY.

IV.—*New and Foreign Rotifera.*

By Surgeon V. Gunson Thorpe, R.N., F.R.M.S.

(*Read* 15*th April*, 1891.)

The Male of Trochosphæra æquatorialis. Pl. VI. fig. 1.

For more than thirty years this rare rotifer has, I believe, eluded rediscovery since Professor Semper first found it in the Philippine Islands. In January 1889, I had the good fortune to find it once again in the Fern Island pond of the Botanical Gardens, Brisbane, Australia. Here it was in company with enormous numbers of *Volvox globator*, and the resemblance it bore both in shape and size to these algæ, as the spherical rotifers and the moving plants circled in and out amongst each other, irresistibly caused one to consider whether we have not here an instance in the microscopic world of "protective mimicry." The time at my disposal for the examination of this remarkable genus was little more than a week, but during this period I was lucky enough to witness the birth of the hitherto unknown male. The male rotifer appeared to lie free in the body-cavity of the female, partially encircled by the intestinal tract (fig. 1 *a*). Nevertheless it was probably surrounded by the invisible wall of the oviduct. During the progress of labour the mother rotifer was perfectly quiescent, and indeed she never recovered vitality.

EXPLANATION OF PLATES VI. & VII.

Trochosphæra æquatorialis.—Fig. 1 *a*. Unborn male in body of female. 1 *b*. Male of *T. æquatorialis*. 1 *c*. Spermatozoa of male. 1 *d*. Winter egg.
Floscularia torquilobata.—Fig. 2. Ventral view.
Brachionus furculatus.—Fig 3 *a*. Dorsal view of female. 3 *b*. Ventral view of lorica of female. 3 *c*. Side view of female. 3 *d*. Dorsal view of male. 3 *e*. Ventral view of male. 3 *f*. Diagrammatic section of male.
Rhinops orbiculodiscus.—Fig. 4 *a*. Ventral view. 4 *b*. Side view.
Notommata cuneata.—Fig. 5 *a*. Dorsal view. 5 *b*. Dorso-lateral view.
Salpina cortina.—Fig. 6.
Anuræa procurva.—Fig. 7 *a*. Dorsal view. 7 *b*. Side view.
Anuræa scutata.—Fig. 8 *a*. Dorsal view. 8 *b*. Side view. 8 *c*. Anterior mental edge of lorica.

The male is totally unlike the female, resembling in its general characteristics the known males among the Melicertidæ. Its form is sacculated, the narrowest part being the head, which is fringed with a wreath of cilia, and bears two minute red eyes, placed somewhat close together (fig. 1 *b*). The body is, as usual, occupied by a large sperm-sac, in which the spermatozoa could be distinctly seen, as well as two or three large translucent vesicles. There is a large penis, but no foot. The spermatozoa have an oval head, with a flagellum about three times the length of the head attached to it along one side (fig. 1 *c*).

In the body of another female *Trochosphæra*, which was dead, I came across a curious organism, which, I have little doubt, is a winter egg (fig. 1 *d*). It was nearly circular in shape, of a flattened appearance, with a dense central nucleus, which had undergone unequal binary division, the whole being covered with long spines.

Floscularia torquilobata. Pl. VI. fig. 2.

Sp. ch.—Lobes five, broad, without knobs. Dorsal lobe arched towards the ventral surface, so that the setæ point towards the foot.

This large and handsome floscule was found, in May 1888, in a solitary bush pool on the shore of Gloucester Passage, coast of Queensland. It resembles in its general aspect and size *F. longicaudata*. The dorsal lobe, however, is three times as long as the two ventral next in size, and is arched across the mouth of the coronal cup, so that the setæ point downwards towards the foot, on the ventral aspect. In other respects its anatomy follows the usual type. Only a single specimen was seen.

Brachionus furculatus. Pl. VI. fig. 3.

Sp. ch.—Occipital spines six, the outermost ones the longest. Two long *lateral* spines behind; temporary only. Male loricated.

This handsome *Brachionus* I found in a pool near Simon's Bay, Cape of Good Hope, in December 1890. The general shape of the lorica resembles the egg of a skate. The antlers, the outermost of the six occipital spines, are the longest, being three times as long as the innermost, and are fantastically twisted in shape. The intermediate pair are mere saw-like projections. The animal carries two long lateral spines till an early period of adult life, and discards them afterwards. I have obtained many specimens which had no lateral spines behind, and two specimens with but a single spine on one side, and in another specimen there was a distinct constriction at the base of one of the lateral spines, apparently the commencement of self-amputation. The dorsal and ventral plates of the lorica are united at their edges for the upper three-fifths of their length. As this point, where the orifices for the lateral antennæ are

situated, the ventral plate leaves the dorsal plate, and suddenly narrows towards the orifice of the foot, which is bounded by two small spines; the floor of the body-cavity, except for this opening, is formed by a triangular basal plate, which meets the dorsal plate on a line joining the orifices of the lateral antennæ (fig. 3, *b*, *c*). Thus there is for the lower two-fifths of the lorica a space left between the basal plate and the lower part of the dorsal plate, and it is in this space that parasitic infusoria, such as species of *Colacium* and *Carchesium*, take up their abode. The pectoral edge is almost straight, with a central notch, and two deep lateral notches, and ends at each extremity in the appearance of a sharp curved spine, about one-third the length of the antler, but not separated from it, forming in fact a strengthening buttress to its base. This pseudo-spine is evidently a transitionary form of the eighth occipital spine, as seen in *B. polycerus*. The animal is able to close the superior orifice of the lorica by bringing the dorsal and ventral edges into mutual contact. The foot can be protruded to a great length, equal to that of the body and antlers together.

The *digestive system* needs no description, as it follows the usual type. There is a large *contractile vesicle* into which the lateral canals can be distinctly traced. There appear to be four vibratile tags on each side. In regard to the *nervous system* there is a large ganglion, in which is imbedded a crimson prism-shaped eye. In one specimen which I examined closely, I found that from the lower edge of the ganglion proceeded three fine nerve-fibres, each of which, whilst crossing the surface of the mastax, expanded into a small nucleated ganglion-cell; then diminishing to their former calibre, they lost themselves on the surface of the stomach and intestinal tract (fig. 3 *a*). Nerve-fibres also supply the dorsal antenna as well as the lateral antennæ, which make their exit, as mentioned before, just above the junction of the dorsal and basal plates. The *ovary* is of a reddish tinge, especially marked when the young ova are in process of formation. The infant female, when in the egg, has the long anterior antlers as well as the posterior spines bent over inwards in such a way that they overlap each other close against the body, so that the whole animal is oval in shape and accurately fits the shell. Immediately after birth these spines are very soft and flexible.

The *male*, many specimens of which I examined, is 1/167 in. in length, and is invested with a distinct lorica. The *dorsal* surface of this lorica is convex, and down its centre runs a high ridge. The occipital edge presents a deep central notch for the protrusion of the dorsal antenna (fig. 3 *d*). The *ventral* surface is deeply concave, and presents at its lower portion a large circular opening, through which a long flexible foot protrudes, as well as a large penis (fig. 3 *e*). There is a large red eye. The male rotifer is extremely active, swimming in a frantic sort of manner through the water, clambering

on to the back of a female, and running all over her like a great parasite, frequently squeezing himself into the space between the dorsal and basal plates of the lorica of the female before actual coition takes place. He also secretes a glutinous material from his foot, by which he anchors himself to the body of the female, twirling round on his own axis at a short distance away.

Size:—Total length of female adult rotifer, 1/70 in. Length of body and anterior spines only, 1/90 in. Width, 1/143 in. Length of male, 1/167 in.

Rhinops orbiculodiscus. Pl. VII. fig. 4.

It is difficult to determine in which genus, whether *Hydatina* or *Rhinops*, this new rotifer should be placed. It is evidently a form intermediate between the two, since, in different points of its anatomy, it combines the characters of both. The corona is that of a *Rhinops* with the proboscis and terminal eyes absent, whilst it resembles a *Hydatina* in the fact that it possesses both a dorsal antenna and two lateral antennæ. On account of the structure of the corona, I propose to place it provisionally in the genus *Rhinops*, and to name it *R. orbiculodiscus*.

I found it in October 1889, in great numbers, in water from the peat bogs amongst the mountains of Donegal, behind Moville. In the following year I was unable to obtain a single specimen. In the same pool were *Mastigocerca bicornis, Dinocharis detractus, Diglena forcipata*, and *Pterodina reflexa*. In another pool nigh to the same place was found *Conochilus volvox*.

The corona is the most characteristic feature in the anatomy of this rotifer. It is a perfect circle in shape, set at an obtuse angle to the ventral surface. It presents a deep cup-like cavity, round the inner edge of which runs the outer ciliary wreath. The inner ciliary wreath consists of large cilia placed on the summit of two tapering cushions which approach each other at the lower part and surround the buccal orifice. The long dorsal proboscis seen in *R. vitrea* is in this species entirely absent, as also are the eye-spots. The corona is in fact that of a *Rhinops* with the dorsal proboscis obliterated.

The ventral surface is flattened, the dorsal surface, on the other hand, swelling out with a fine sweeping curve into a globular form, well seen when the creature is viewed from the side (fig. 4 *b*), and then suddenly diminishing behind to the base of the foot. The foot is about one-third the length of the body, and is terminated by two toes.

The intestinal tract is of the usual type, a mastax, followed by a capacious stomach, and an intestine ending on the dorsal aspect at the base of the foot. Gastric glands are seen on both sides of the stomach. There is a large translucent ovary, and a large contractile vesicle on the ventral side of the base of the foot. The two lateral

antennæ are situated, one on each side, at the lower part of the globular dorsal surface. They can be seen distinctly also from the ventral aspect. A single dorsal antenna occupies the mid-line just below the upper border of the corona.

Notommata cuneata. Pl. VII. fig. 5.

This pretty little species I found in considerable numbers in a quarry pool in Bickleigh Vale, Devonshire, in April 1890. Its general shape is that of a wedge, the broader extremity being the head. The pair of *toes* are long and curved, their length being one-third that of the body. There is a pair of *auricles*, the setæ of which are unusually long. The *trophi* are of the usual type; the *stomach* is capacious; a *contractile vesicle* is also present. The crimson *eye* is conspicuous. The little creature secretes a glutinous material from its toes, by which it is in the habit of anchoring itself to surrounding objects. Length 1/300 in.

Salpina cortina. Pl. VII. fig. 6.

This rotifer was found in the ponds of the Acclimatization Gardens, Brisbane, Australia, in January 1887. The *occipital spines* are wanting; the *pectoral* pair short; and the *lumbar* spine is considerably longer than the *alvine* spines. There is a deep notch in the posterior edge of the lorica, uniting the lumbar and alvine spines. The *toes* are two-thirds the length of the whole body. There is a large ganglion, with a conspicuous crimson eye. The rest of the anatomy is of the usual type.

Anuræa procurva. Pl. VII. fig 7.

The only water supply in the desolate volcanic island of Ascension is brought to the town from Green Mountain, an oasis in the midst of ashes and cinders, by an aqueduct of pipes, seven miles in length, broken at regular intervals by covered tanks or reservoirs. The water in the cattle trough in front of one of these tanks, known by the expressive name of "God-be-thanked" Tank, I found this January (1891), to be swarming with *Pedalion mirum*, in company with a species of *Anuræa*, which I believe to be new.

When viewed from the front, one would be inclined to consider *A. procurva* but a variety of *A. aculeata*. When, however, a side view is obtained, it is at once seen that the lorica is considerably curved, so that the ventral surface is deeply concave, and that the anterior and posterior extremities project much beyond the line of the lateral edges. In regard to the occipital spines, six in number, the middle pair (antlers) are by far the longest, and are curved forwards. The two posterior spines are unequal. The lorica is hexagonally

tesselated, similarly to *A. aculeata;* the tesselations, however, are not very distinct. A large red *eye* is present. Length 1/200 in.

Anuræa scutata. Pl. VII. fig. 8.

This species, found in the fountain of the Botanical Gardens, Brisbane, in January 1889, is relatively both broader and deeper than *A. aculeata.* The curve of the dorsal surface is sweeping, whilst the ventral surface is comparatively flat. The occipital spines are six, the middle pair long and procurved. The anterior mental edge has a deep notch at its middle. The posterior spines are unequal, the length of one being that of the body; the other is degenerated. A single red *eye* is present. Length about 1/120 in.

V.—*A New Method of Infiltrating Osseous and Dental Tissues.*

By T. Charters White, M.R.C.S., F.R.M.S.

(*Read* 18*th March*, 1891.)

It is well known to all who are in the habit of mounting osseous or dental tissues in Canada balsam, that great care must be observed in order to keep out this substance from any existing tubular or cavernous elements in these tissues, in order to obviate the inevitable obliteration which would arise in consequence. It therefore occurred to me that if such cavities could be filled by some substance insoluble in the balsam, such obliteration would be prevented, and the minutest features of the section rendered visible. Several methods presented themselves to my mind, but none seemed to have greater advantages than that I wish to introduce to your notice this evening. I do not pretend that this method will demonstrate anything fresh in a known structure, but should abnormal histological elements be present they will be made evident more readily, while the well-known obliteration will be entirely removed. The plan by which for many years I have mounted hard dental tissues answered very well, and it may be of help to recall it as it has proved so useful in the hands of others who have adopted it. It was to grind the dental or osseous sections between two plates of ground glass, with water and pumice powder, till sufficiently thin, finishing them off at last with old and worn-out ground glass and water alone. This, while it allowed the grinding down to proceed more slowly, at the same time polished the section ; this being saturated with water only required cleaning and its surfaces dried, when it might be mounted in fairly stiff balsam, *but without heat.* In this manner the internal cavities remained impermeable to the balsam. Thinking over this method with a view to its improvement, the thought occurred to me that if some method of infiltration could be adopted, such as is frequently employed in preparing the soft tissues, an advantage could be gained ; and I set to work to carry this thought into execution after this manner. The section may be cut or ground moderately thin and soaked in ether for about 24 hours or more, it is immaterial ; it may then be transferred to a thin collodion stained with fuchsin, where it may remain for two or three days to allow the stained coliodion to follow the ether into the minutest ramifications of the tissue. In this manner not only the lacunæ of bone are infiltrated, but their radiating canaliculi also, and the dentinal tubuli, equally fine in dimensions, are frequently found filled to their ultimate terminations. The section may now be placed in methylated spirit which will harden the collodion, and it may remain in this till a suitable opportunity arises for grinding it down to its final thinness. The collodion being insoluble in water, no detrimental action can ensue from the grinding down, but especial care should be taken to finish off with *old*

ground glass and water only, to avoid the adherence of particles of pumice to the collodion or in surface cavities, which would detract from the cleanliness and beauty of the preparation. When sufficiently thin, the section may be mounted, *surface dry*, in stiff Canada balsam, or what may be better, the styrax used for mounting diatoms, but the mounting should by preference be accomplished without the application of heat, or at most only the slightest increase of temperature, to avoid vaporizing the moisture contained in the cavities or tubes of the tissue. If the temperature be raised to a greater extent the mounting medium runs in, leaving the intimate structure filled with the red collodion, a result which may be useful under some circumstances. By this method any unsuspected or abnormal cavities are made very evident by the coloured collodion. Brittle tissues are made less friable by the toughness of the collodion, and the work of grinding down much facilitated. I may here give a useful suggestion in reference to the staining of the collodion with the fuchsin: this dye should be mixed in the methylated spirit used for making the collodion, and the requisite quantity of ether be added and well shaken up, then the pyroxiline added. If the alcoholic solution of fuchsin is added to the collodion after it is mixed the alcohol in this solution precipitates the collodion in a gummy mass, and so toughens it that it fails to permeate the tissue, but prepared in the manner I have just indicated it preserves its fluidity, and should it by evaporation become thickened it can be diluted with a little more ether. I have tried the other anilin dyes such as Bismarck brown, iodine-green, and methyl-violet, but cannot at present get such a satisfactory result as I have with fuchsin.

This method as applied to the osseous and dental tissues is, I believe, new, and might be regarded as something almost too simple to bring before a body of such accomplished microscopists as form the bulk of this Society; yet the suggestion of it may lead to its employment in other directions, and I hope that much benefit may arise to its employers from its underlying possibilities.

VI.—*On Bull's-eyes for the Microscope.*

By E. M. Nelson, F.R.M.S.

(*Read 18th March*, 1891.)

Having lately been investigating the optical principles involved in the construction of lantern condensers, I have found some points which are applicable to, and of service in, the cause of microscopy. With regard to the lantern, my aim in the first instance was to construct a condenser which could be used either with lime-light or with a mineral oil lamp. I designed a triple, consisting of two menisci and a plano-convex of crown, the front lens being removable, so that the two remaining lenses formed a double condenser for use with mineral oil.

The triple, when tried with lime-light, gave several important results:—

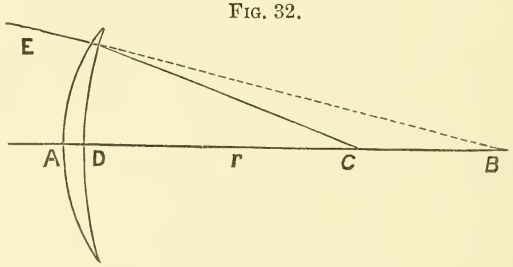
1st. The light secured was about double that given by ordinary forms.

2nd. The definition on the screen was undoubtedly improved. This latter result might have been expected from the former, because of the increase of light that was sent through the darker portion of the picture, but there was also a marked improvement in what is known as the high lights, and this certainly I did not expect. The conclusion that forced itself upon me was that the case was analogous to that of the Microscope—viz. a more perfectly constructed condenser gave a more perfect image. Although my triple greatly reduced the spherical aberration there was still a considerable amount left, owing to the conditions imposed by having the two lenses suited for a mineral oil illuminant. Seeing, however, so much improvement in the definition, I have since computed a quadruple condenser of minimum aberration, which will, I feel confident, yield still better results.

It was this improvement in the definition which led me to turn my attention to Microscope bull's-eyes. These I found were constructed on principles of maximum aberration, or rather on no principles at all. When, some years ago, I adapted the Herschel doublet to the Microscope bull's-eye, thinking that the form was well known, I left it entirely in the hands of the optician, but on more close examination I now find that the combination supplied has no point of resemblance to Herschel's doublet, of which I have found in several old books a description. Many years ago it was discovered, by whom I do not know, that light falling on a dense medium of refractive index μ bounded by a spherical surface, would, under certain conditions, be refracted without aberration to another point. The conditions were, that the distance from the point from which the

light issued to the centre of curvature, should be to the radius, as the refractive index was to unity. When those conditions were obtained, then all the light passed without aberration to another point. It is this theorem which makes it possible to construct an aplanatic meniscus. For if, in a converging meniscus, the more convex curve satisfies the above conditions, the shallower curve may be made any radius from the focal point, and therefore the light will pass through that surface without refraction. Fig. 32 makes this abundantly

Fig. 32.



evident. Let the ray E fall on the convex curve A, whose radius is A r, and let B, which is technically known as the focus of E, be the point where E produced will cut the axis, and let μ the refractive index of A D = 1·5. Then, if A r : r B :: 1 : 1·5, all rays falling on A which have their focus at B will be refracted without aberration to the conjugate focus C. All that is necessary now is, from the centre C to describe the curve D, and the meniscus A D is constructed, for it is quite evident that all the rays refracted by A to C are radii of D, and so pass through without refraction.

The converse problem is also true. If a light is placed at C, all rays falling on the meniscus A D will be refracted aplanatically as if they came from B. So far the books help one, but as r and B are both unknown, it is a tedious business to construct an aplanatic meniscus for purposes of a bull's-eye, &c. I have investigated the problem, and have devised some very simple formulæ which make the construction of an aplanatic meniscus perfectly easy. Let us see what we have given us. We have two things, viz. the refractive index of the medium, and C D, the back focus. Now, we first require the distance A C, or the back focus + the thickness of the lens. The best way of determining the thickness of the lens is by drawing it. Extreme accuracy in this point is not necessary. Having found A C call it P; and A B, P′; A r, r; and let μ = the refractive index. Then

$$r = \frac{\mu \mathrm{P}}{\mu + 1}$$

and

$$\mathrm{P}' = \mu \mathrm{P}.$$

Having found r draw it. It is only necessary to lay off an angle at

C to represent the aperture, by which means the diameter of the lens may be found. This being determined from the centre C, we can draw the curve D, and so the meniscus is constructed. If it is found that the proper amount has not been allowed for A D, the thickness of the lens, it can now be measured, and the curve computed with the new value of A C or P. To complete the doublet it is necessary to place a converging lens of minimum aberration in front of A to parallelize the rays which have their focus at B.

Some care is necessary in doing this, for it is important that the focus for the marginal rays be accurately determined, leaving the aberration to act on the central pencils, as they are of less importance. First, we must decide the form of the lens. In the case of a glass of low refractive index, it would be better, perhaps, to have a crossed lens, but with flint of 1·62 I find that the difference in the coefficients for aberration in the plano and in the crossed lens amounts to only ·006, whilst in glass, whose refractive index is 1·516, it is ·075. Crossing a flint lens is therefore a work of supererogation. Let us, in the first instance, investigate the procedure with a plano-convex flint lens where $\mu = 1{\cdot}62$. The plane side will face A.

Its focal length will obviously be B A + the distance between the lenses + the distance of the nodal point from the plane side + the spherical aberration for the semidiameter of the lens. B A or P′ we already know from the formula $P' = \mu P$. The distance between the lenses may be made small, say 1/20 in.; n the distance of the nodal point from the plane side can be found by the formula $n = \frac{d}{\mu}$ where d = the thickness of the lens.

To determine the spherical aberration is a longer business, and as this paper is intended to be entirely practical and not theoretical I have no intention of giving the formulæ at length, especially as I have done so previously (R. M. J., 1887, p. 928.) It will be sufficient to point out that it consists of the product of two quantities which we will call a and b. The first of these, viz. a, varies principally with the refractive index of the glass used. When $\mu = 1{\cdot}516$, for a crossed lens, $a = 1{\cdot}025$, and for a plano-convex, $a = 1{\cdot}1$. When $\mu = 1{\cdot}62$, for a plano-convex lens, $a = {\cdot}804$.

The quantity b is the square of the semidiameter of the lens divided by the focus: thus if y is the semidiameter, $b = \frac{y^2}{f}$. The total spherical aberration is $a\,b$.

If we put in for the value of f the sum of the values already obtained, viz. the distance B A or P′ + the distance between the lenses, say 1/20 in. + the distance of the nodal point from the plane side of the lens, sufficient accuracy will be obtained; if, however, extreme accuracy be required, determine the spherical aberration by this value of f, and by adding it to the above quantities obtain a new value for f by which a true value may be obtained of b.

Having found f the required focus, the radius is easily deduced by the formula $r' = f(\mu - 1)$.

In assigning a value to y we must know the diameter of the lens. It may be found thus:—having drawn the meniscus and found the point B or P′ and having laid off the angle of aperture at C (fig. 32) through the point where the extreme ray from C meets the curve A, draw B E. E being the limiting ray it determines the diameter of the lens and consequently the value of y.

If it is required to further diminish the aberration it can be accomplished by crossing the second lens. As stated above, it is not necessary to do this when the lens is of 1·62 ref. index. A plano flint is however a good deal better than a crossed crown, the difference of the coefficient in favour of the flint being ·22. Therefore if it was a matter of equal cost between a crossed crown and a plano flint, the flint should be chosen, and as the meniscus is aplanatic, whether made of crown or flint, it might be cheaper to make the meniscus of crown and combine it with a plano flint. The combination would yield a result as far as aberration was concerned almost equal to that of a doublet composed wholly of flint. As crown glass has a green tint, where the colour of the light is of importance flint glass only should be used.

To find the radii r and s of a crossed lens of given focus, it is only necessary to multiply the focus by the constants H and K thus:—

$$r = \mathrm{H}f$$
$$s = \mathrm{K}f.$$

For glass of ref. index 1·516; H = ·5935, and K = − 3·944.
For glass of ref. index 1·62; H = ·653, and K = − 12·06.

In a crossed lens the flatter curve always faces the meniscus.

It should be remarked that the formula for the nodal point given above, $n = \frac{d}{\mu}$, is not strictly accurate for a crossed lens, but it is abundantly so for my purpose. The distance n is measured from the flatter curve into the substance of the lens, similar to the plano.

The spherical aberration may be considerably further reduced by placing a second aplanatic meniscus next the first, so making the condenser a triple (fig. 35).

The formulæ for computing the radii of the second meniscus are precisely similar to those of the first.

Let Q and Q′ be the terms of the foci of the second meniscus corresponding to P and P′ of the first.

As far as the second meniscus is concerned we have merely to regard the light as emanating from B and neglect altogether the presence of the first meniscus.

Q will therefore equal the distance A B or P′ + the distance between the menisci + the thickness of the second meniscus. Then

$$r' = \frac{\mu Q}{\mu + 1}.$$

s' will be drawn from centre B to the point where E meets r (fig. 32).

The formula $Q' = \mu Q$ gives Q′ which is the point to be used in determining f for the third lens in the same way as the point B or P′ was used in finding the focus of the plano or crossed lens for the double.

The reason why the aberration is decreased by the insertion of a second meniscus is because of the decrease of the factor b by the increase of the denominator in the fraction $\frac{y^2}{f}$ by the removal of the focus from P′ to Q′. The total spherical aberration $a\,b$ is therefore reduced.

In the triple the light meets the surfaces at no great obliquity, consequently there is not much loss by reflection.

With regard to the diameter and focal length of a combination suitable for a Microscope bull's-eye, if it is required to fill the back lens of any substage condenser 1½ in. would be more than sufficient, but for the illumination of opaque objects by means of lieberkuhns, parabolic reflectors, &c., perhaps 2 inches would be better. Naturally, with a given back focus, the larger the diameter the larger will be the angle of light that is parallelized, but unless the whole of the parallelized beam is utilized there will be a corresponding loss. Taking all things into consideration I think a 2-in. will probably be the most useful size. As to focus, or rather working distance, with one of my metal chimneys having a 3 × 1 slip I find that 1 in. will be sufficient.

Allowance will have to be made for the horns of the meniscus as well as for the brass mount. I have therefore made

$$P = 1{\cdot}6''.$$

Fig. 33 shows the proper mode of mounting a condenser.

Fig. 33.

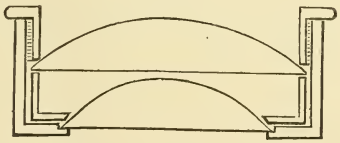


Fig. 34 is a drawing of a doublet of plate glass, $\mu = 1{\cdot}516$; 2 in. clear aperture; angle 70°; working distance 1·0″.

First lens, a meniscus, diameter 1·7″.

$$r = + \cdot 964''.$$
$$s = + 1 \cdot 375''.$$

Second lens, double convex crossed, diameter 2·1″.

$$r' = + 1 \cdot 816''$$
$$s' = - 12 \cdot 07''.$$

Distance between the lenses ·05″.

$P = 1 \cdot 6''$ $P' = 2 \cdot 425''.$ $n P' = 2 \cdot 725''.$

Spherical aberration $\delta f = - \cdot 335''.$

$\delta F = - \cdot 168''.$ $f = n P + \delta f = 3 \cdot 06''.$

Fig. 34.

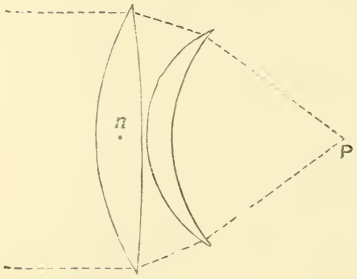


Fig. 35.

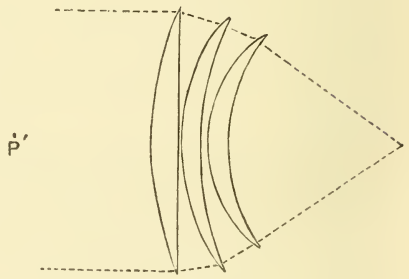


Fig. 35 is a drawing of a triple of flint $\mu = 1 \cdot 62$; 2 in. of clear aperture; angle 70°. The first lens is a meniscus, diameter, 1·65″.

$$r = + \cdot 958''$$
$$s = + 1 \cdot 35''.$$

The second lens is a meniscus, diameter 2·0″.

$$r' = + 1 \cdot 67''$$
$$s' = + 2 \cdot 55''.$$

The third lens is a plano-convex, diameter 2·1″.

$$r'' = + 2 \cdot 914''.$$

Distance between the lenses ·05″.

$P = 1 \cdot 55''.$ $P' = 2 \cdot 51''.$ $Q = 2 \cdot 7''.$ $Q' = 4 \cdot 37''.$

$n Q' = 4 \cdot 53''.$ $\delta f = - \cdot 17''.$ $\delta F = - \cdot 0226''.$

$$f = n Q' + \delta f = 4 \cdot 7''.$$

A still better doublet than that in fig. 34 could be made by combining with the plate glass meniscus there shown a plano-convex of flint, $\mu = 1 \cdot 62$; diameter 2·1″.

$$r' = + 1 \cdot 83''.$$

$n P' = 2 \cdot 675''.$ $\delta f = - \cdot 272''.$

$\delta F = - \cdot 132''.$ $f = 2 \cdot 95''.$

The spherical aberration of this form is therefore ·109″ greater than that of the flint triple, and ·036″ less than that of the plate glass double.

SUMMARY

OF CURRENT RESEARCHES RELATING TO

ZOOLOGY AND BOTANY

(*principally Invertebrata and Cryptogamia*),

MICROSCOPY, &c.,

INCLUDING ORIGINAL COMMUNICATIONS FROM FELLOWS AND OTHERS.*

ZOOLOGY.

A. VERTEBRATA:—Embryology, Histology, and General.

a. Embryology.†

Theory of the Structure of the Placenta.‡—Mr. C. S. Minot's theory may be shortly summarized thus:—He looks upon the placenta as an organ of the chorion; primitively the chorion had its own circulation and formed the discoidal placenta by developing villi which grew down into the degenerating uterine mucosa; by the degeneration of the maternal tissues the maternal blood is brought closer to the villi, and the degeneration may go so far that all the tissue of the uterus between the villi disappears. A layer of the mucosa is preserved between the ends of the villi and the muscular layer of the uterus to form the so-called decidua; the placenta receives its fœtal blood by the means of large vessels running in the mesoderm of the allantois. From this discoidal chorionic placenta the zonary placenta of Carnivora, the diffuse placenta of the lower Primates, and the metadiscoidal placenta of Man have been evolved.

A second type of placenta, perhaps evolved from the first, is found in Ungulates, and is characterized by a vascular allantoic vesicle uniting with a now vascular chorion to form the fœtal placenta, and by the absence of degeneration in the maternal tissue. This is the allantoic placenta.

First Stages of Placental Union in Man.§—Prof. E. Selenka brings forward evidence against the general opinion that the ovum during the

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

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

‡ Anat. Anzeig., vi. (1891) pp. 125–30.

§ Biol. Centralbl., x. (1891) pp. 737–44.

first three or four weeks of its development lies free within its capsule. On the contrary, in the first week of development it is firmly and permanently united to the uterus, for the villi of the chorion grow into the openings of the uterine glands. Selenka bases this conclusion confidently on the results of his investigation of early stages both in apes and in man. Moreover, he urges the following considerations:—(1) If the ovum lie free for weeks, its encapsuling by the decidua is unintelligible, for this surely results from the stimulus of contact between ovum and uterus; (2) if the ovum does not unite very early with the uterine epithelium, the latter should be demonstrable on the internal surface of the capsule cavity, but it is not; (3) the supposition of a double-layered chorion ectoderm is unsupported by any analogy; (4) except on Selenka's conclusion, the early nutrition of the ovum is unintelligible.

Development of Apes.*—Prof. E. Selenka has a preliminary notice of the results of his studies on the development of Apes. The most primitive type is to be sought for in those Apes in which the germinal vesicle is not surrounded by a decidua reflexa; there are here two placentæ, one on the dorsal surface of the fœtus and the other on the ventral surface of the germinal vesicle. From this type two others have arisen independently; in both the decidua reflexa forms a capsule round the germinal vesicle. If the reflexa contains both blood-vessels and uterine glands two discoid placentæ are formed, but if these are wanting the second placenta remains quite rudimentary.

The most primitive form, or placenta bidiscoidalis typica, is found in all Catarrhine Monkeys of the Old World, but not in Man or the higher Apes. The placenta bidiscoidalis circumvallata, which has, as yet, been seen only in *Hylobates* (the Gibbon), differs only from the typical in that the ventral uterine placenta does not arise from the ventral, but rather from the dorsal wall of the uterus. The placenta monodiscoidalis or discoidalis, which is found in the other Anthropoid Apes and in Man, must be regarded as homologous with the dorsoplacenta of other Apes.

Great as the differences in the placentation of the three types appears to be, those of the other embryonic membranes and of the fœtuses themselves are very slight. The rudiment of the placenta, for example, is always the same. A slight sketch is given of the developmental history of the Catarrhine Monkey *Semnopithecus maurus*. The general lesson is that, in Apes and Men some embryonic organs are developed earlier, and others later than in other Mammals. The precocious structures are the numerous chorionic villi, the cœlomic sacs, and the stalk of the allantois. Those that are later are the yolk-sac, whose vascular plexus is not developed for some time, and which must be regarded as a vestigial organ; the allantoic cavity is long in appearing.

The characteristic points are the loose tissue of the somatopleure which lines the chorion, the persistent stalk of the amnion, the outgrowth of the amnion and its fusion with the chorion, the vestigial nature of the yolk-sac, the formation of two opposed placentæ, one of which may remain rudimentary, and the attachment of the non-placental part of the embryonic sac to the surrounding uterine wall.

* SB. K. Preuss. Akad. Wiss., 1890, pp. 1257-62.

Development of the Germinal Layers in Sorex.*—Prof. A. A. W. Hubrecht, in the second of his studies in mammalian embryology, describes the formation of the germinal layers in the shrew, and discusses the general problems connected with the subject.

The earliest stage of which sections were made exhibits a distinct zona pellucida, internally clothed by a layer of flattened cells—the trophoblast, while at one spot there is an agglomeration of 50–60 larger cells—the material for the embryonic epiblast and for the hypoblast. The segmentation cavity beneath the polar thickening is distinct, though not yet very spacious; after the development of the cœnogenetic hypoblast, it becomes the cavity of the yolk-sac. At this stage the embryos were still free in the uterus.

The blastocyst widens, its cells are stretched, and the zona becomes thinner. In the last phases of the didermic stage, just before the appearance of a mesoblast and a gastrula ridge or primitive streak, the zona reaches its limit of tenuity. After that it disappears and the trophoblast is attached to the uterine tissue. From the embryonic knob hypoblast cells originate, which gradually form a continuous layer within the trophoblast. It seems likely that the trophoblast extends as a thin layer above the embryonic knob. After the migration of hypoblast cells from the embryonic knob, the patch of epiblast which remains may be termed the embryonic shield.

The hypoblast forms a complete and closed sac, clothing the entire inner surface of the trophoblast. Just below the anterior end of the embryonic shield the hypoblast undergoes an important modification, forming a patch in which a differentiation occurs, which ultimately leads to the formation of the notochord and the lateral mesoblast plates. As part of this patch will develope into the anterior portion of the notochord, it is called the protochordal plate. It is remarkable that this should precede the first hints of a gastrula ridge.

Towards the origin and further development of the middle layer in *Sorex vulgaris* three distinct sources contribute. These are:—(1) The protochordal plate; (2) the gastrula-ridge and its median prolongation forwards—the protochordal wedge which advances between the epiblast and the hypoblast; (3) an annular zone of hypoblast situated just outside the limits of the embryonic shield, and thus inclosing—but at the outset independent of—the protochordal plate. But soon the mesoblast becomes a confluent layer, and grows by the division of its own cells.

In his theoretical considerations on the gastrulation of the Mammalia, Prof. Hubrecht emphasizes the principle of precocious segregation as applied to part of the hypoblast. A didermic stage of the blastocyst is inaugurated before the actual process of gastrulation has set in. But another portion of the hypoblast arises in more palingenetic fashion, namely, in the gastrula ridge. An explanation is given of the manner in which the union of the palingenetic and cœnogenetic hypoblast comes about.

In explanation of the persistence of the yolk-sac in Didelphia and Monodelphia, Prof. Hubrecht notes that, for a satisfactory working of the new nutritive arrangements of the embryo, "it is undoubtedly of the utmost importance that the surface of the area vasculosa should be

* Quart. Journ. Micr. Sci., xxxi. (1890) pp. 499–562 (7 pls.).

stretched to its maximum extent, and at the same time should be elastic against pressure tending to throw it into folds." The change required would thus be the substitution of liquid contents instead of nutritive contents. With the absorption and retention of this liquid, under a certain pressure, the trophoblast is specially concerned. Moreover, the spacious blastocyst affords safe lodging for the developing head of the embryo. But the function of the trophoblast will be rendered more effectual if the hypoblast follows suit, and constitutes as soon as possible an inner lining to the trophoblast sac. By these and other considerations Prof. Hubrecht shows the necessity for the precocious segregation of part of the hypoblast in mammals.

Nomenclature of Chicken Embryos for Teaching Purposes.*—Prof. W. Baldwin Spencer suggests the use of fixed and simple designations to indicate the stages in chicken embryos, and he recommends the use of letters of the alphabet, such as was adopted by Prof. Balfour in his description of the early stages of Elasmobranch fishes. He defines the stages, and gives figures to explain and illustrate his meaning.

Development of Salamandra atra.†—Prof. R. Wiedersheim has examined a large number of females, and while for the most part confirming the observations of Schreibers, C. Th. Siebold, and Czermak, has found out more than one new fact of importance. In one case, instead of two embryos there were three; in another exceptional case there were four. Prof. Wiedersheim killed the animals in sublimate solution and cut out the gravid uteri. Yet, except in two cases perhaps abortive, the embryos remained alive, so securely closed is the distal end of the duct. The histology of the oviduct is described:—the numerous vessels between the serous and muscular layers, the plaited mucosa, the cilia all over the surface, the thousands of leucocytes in the intercellular spaces of the sub-mucosa and mucosa. In the uterus these spaces are occupied by crowds of red blood-corpuscles which burst the mucosa and are set free in the cavity in which the embryo lies. In this fluid, rich in oxygen and in nourishment, the embryo breathes and feeds. Its mode of respiration is no longer an enigma. As the material furnished by the undeveloped ova becomes exhausted there is a more abundant supply of blood, lymph, and epithelial débris from the wall of the uterus. After birth the mucosa is renewed, a process which recalls similar phenomena in mammals.

Disputed Points in Teleostean Embryology.‡—Mr. J. T. Cunningham draws attention to some of the firmly established facts, and distinguishes the sound from the unsound in recent descriptions and arguments. In many ova of Teleosteans there is no element in the egg-cell other than the pellucid yolk and the peripheral pellicle of protoplasm; in the gurnard and mackerel there is a somewhat large globule of oil; in others there are several free in the yolk or fixed in the cortical protoplasm. In all non-pelagic and in some pelagic ova the yolk is discontinuous, consisting of many yolk-spherules. Yolk-segments, intermediate between numerous yolk-spherules and the homogeneous yolk of

* Proc. Roy Soc. Victoria, 1890, pp. 23-6 (4 pls.).
† Arch. f. Mikr. Anat., xxxvi. (1890) pp. 469-82 (1 pl.).
‡ Ann. and Mag. Nat. Hist., vii. (1891) pp. 203-21.

a typical ovum, have, of course, nothing to do with segmentation. The development of the "vitelline membrane" has not been satisfactorily worked out. The segmentation-cavity of the segmented Teleostean ovum is homologous with that of other ova. Accepting the conclusions of Agassiz and Whitman in regard to the origin of the nucleated periblast, Mr. Cunningham adheres to his own observation that, as the nuclei from the marginal cells from the sixteen-cell stage onwards continually divide, cell-division also takes place in these cells, but at a slower rate than the nuclear division. In consequence of this, new cells are continually being separated from the ring of periblast at the same time that the nuclei in that ring continually become more numerous, and extend outwards and inwards from the marginal region of the blastoderm. The segmentation of cells from the Teleostean periblast to form hypoblastic and mesoblastic tissues corresponds perfectly with the subdivision of the yolk-cells in *Petromyzon* and Amphibians which gives rise to hypoblast and mesoblast in these forms. The real representative of the gastrula-cavity in Teleosteans is Kupffer's vesicle.

Later Larval Development of Amphioxus.*—Mr. A. Willey gives, at the commencement of his paper, a useful résumé of the entire development of *Amphioxus*.

I. The period of embryonic development comprises the first thirty-two hours. It commences with the segmentation of the ovum, and ends with the formation of the first gill-cleft.

(*a*) In the first eight hours, during which the embryo is confined within the vitelline membrane, the usual early differentiations are effected.

(*b*) After emerging from the membrane there is a successive formation of myocœlomic or archenteric pouches to the number of fourteen pairs. The myotomes which are added after this period never communicate with the intestine.

II. In the period of early larval development fresh gill-slits appear metamerically, slightly to the right side of the median line (subsequently passing well up to the right side) to the number of twelve to fifteen. Towards the close of this period the longitudinal metapleural folds appear, and the closure of the atrium commences behind by the fusion of the small subatrial ridges which are developed in the inner face of the metapleura.

III. The period of later larval development is that in which the second row of gill-slits is formed on the right side; the first or primary row crosses to the left side, the mouth assumes an anterior median and vertical position, the preoral cirri appear, and the endostyle is developed from its pre-existing rudiment.

IV. The adolescent period is marked by the attainment by the young *Amphioxus* of most of the essential features of adult structure; it now definitely ceases to lead a pelagic life and takes up its abode in the sand, where its further growth in size and maturity is accomplished.

The third period, or that now described, is divided into eight stages, in the consideration of which it is necessary to distinguish between what takes place on the right and what on the left side.

* Quart. Journ. Micr. Sci., xxxii. (1891) pp. 183–234 (3 pls.).

At first there are, on the right side, fourteen primary slits, none closing; above these are six secondary thickenings; the endostyle is in front of all the slits and the atrium is widely open anteriorly. On the left side there is a large lateral mouth, and one to two elements of the buccal skeleton. In the next three stages we find the fourteenth slit (on the right side) become closed, the thirteenth closing and the first very small; the secondary thickenings become slits, and some commence to form tongue-bars; the endostyle extends a short way backwards; and the atrium becomes closed. On the left side, we find the mouth bending round to the middle line, and the oral hood and the cirri beginning to make their appearance.

In the stage called the fifth there are twelve primary slits, just visible at the base of the pharynx, and the twelfth is closing; the first undergoes atrophy; there are eight secondary slits, the larger of which have complete tongue-bars; the endostyle extends further back. On the left side the primary bars have not yet quite appeared, while the upper and lower portions of the oral hood have joined. The club-shaped gland of the right side undergoes atrophy.

In the three succeeding stages the gill-slits tend more and more to arrange themselves in a bilaterally symmetrical manner, and there are at last eight on each side; the endostyle increases gradually in size.

The author gives a useful summary of the history of the individual structures, and then proceeds to certain general considerations. He thinks that the remarkable asymmetry of the larva may be ultimately traced to the adaptive forward extension of the notochord; the asymmetry is, then, a purely ontogenetic phenomenon, and is not an ancestral character. Reasons are given for regarding the club-shaped gland as a modified gill-slit of the right side, the corresponding slit of the left being represented by the first primary slit.

With regard to the endostyle, evidence is adduced to show that its position in the adult *Amphioxus* is secondary, and that, in its origin, it is perfectly homologous with the endostyle of Ascidians.

Some evidence is adduced in support of the startling assertion that the gill-slits or branchial stigmata of the Ascidians are not homologous with those of *Amphioxus* in origin, position, or relations. In the latter the slits are formed metamerically in the segmented region of the trunk; in the former they appear in front of the segmented region, and do not arise metamerically but irregularly. The common ancestor of the two groups cannot be properly imagined till we have further knowledge as to the significance of the primary pair of diverticula of the prechordal vesicle, and as to the function of the club-shaped gland. It is probable that gill-slits were present in the segmented region of the trunk and have been lost by existing Ascidians; if the evidence as to the club-shaped gland being a modified gill-slit is accepted, there must have been at least one pair of such glands.

Development of Muscular Fibres.*—M. L. Roule has studied, chiefly in *Porcellio*, the development of striated muscular fibres. Some of the elements of the mesoderm which are arranged in compact groups on

* Comptes Rendus, cxii. (1891) pp. 245-6.

the sides of the body of the embryo form the rudiments of the musculature of the body.

Each of these cells gives rise to a primitive fibre, by withdrawing its pseudopodial expansions, and growing by the addition of new protoplasmic material; this latter is not formed of granular plasm, like that already existing, but of contractile substance. This substance is at first deposited at the two extremities of the cell, then extends over the entire periphery, the deposit being always most abundant towards the ends; in this way the element grows along its longitudinal axis. The primitive granular protoplasm with the nucleus which it incloses thus becomes enveloped and set in the middle of a sheath of contractile substance. The differentiation into fibrils commences towards the centre and not the periphery of the cell; a transverse section taken at the level of the nucleus shows this nucleus in the very axis of the fibre, and from within outwards, the granular protoplasm, the deep contractile substance divided into fibrils, and the still homogeneous contractile peripheral substance.

This is different to what obtains in Vertebrates; the contractile substance in them appears first on one or both surfaces of the primitive element, and not at its two extremities; moreover, the primitive fibrils first appear towards the periphery of the cell, and not in its central region. The differences may be explained as due to the epithelial origin of the somatic muscular fibres of Vertebrates, and confirm, while they extend, the views of the brothers Hertwig as to the nature of the cœlom.

Both the epithelial as well as the mesenchymatous types of origin apply to smooth as much as to striated fibres; the smooth fibres of Nematodes, for example, are developed in the same way as the striated somatic fibres of Vertebrates, and the smooth muscles of Molluscs like the striated fibres of Arthropods. In both cases the nucleus is occasionally single, and this is frequently the case with smooth fibres, while it sometimes multiplies and converts the primitive element into a multinucleated primitive fibre.

Development of Sympathetic Nervous System in Mammals.*—Prof. A. M. Paterson has investigated the development of the main sympathetic system, chiefly in Rodents. The first event is the development of the main sympathetic cord. It is formed as a cellular rod or column, uniform in outline, and without ganglia or constrictions. It appears in and is derived from the mesoblastic tissue on either side of the embryonic aorta, and in front of the growing vertebral column. The cord appears after the formation of the roots and ganglia of the spinal nerves, and is at first entirely independent of them.

The connection with the spinal nerves is secondary; the inferior primary division of a (typical) spinal nerve divides, on reaching the junction of body-wall and splanchnopleure, into a somatic and a splanchnic branch. The latter gradually grows mesially and ventrally, and finally becomes connected with the sympathetic; some part of it does not join, but passes on into the splanchnic area. In the anterior part, however, of the thorax the whole of the splanchnic branch appears to be joined to the sympathetic cord.

* Phil. Trans., 181 B. (1891) pp. 159-86 (9 pls.).

The formation of the ganglia on the main cord of the sympathetic is a subsequent event, and is subordinate to the connection of the splanchnic branches of the spinal nerves with the cord. The causes leading to the formation of the ganglia are: mainly, the junction of the splanchnic branches, and the accession of a large number of nerve-branches at the point of entrance; the consequent persistence of the cells of the cord, which are joined by these nerves, as ganglion cells; and, to a less extent, the anatomical relations of the cord to the bony segments, &c., over which it passes; for these, in their growth, cause indentation of the cord at certain points.

Details are given as to the cephalic and caudal terminations and the peripheral branches.

From the morphological point of view, the most important of Prof. Patterson's conclusions are (1) that the sympathetic system is not a specialized portion of the central nervous system but has an independent origin, and is only secondarily connected with the cerebro-spinal system, and (2) that it is developed from the mesoblast.

It is very possible that under the term "sympathetic nervous system" there have been included two structures, entirely independent in nature, origin and function, one the sympathetic and the other the nervous system proper.

Degeneration of the Follicle in the Mammalian Ovary.*—Dr. T. Schottlaender finds that the degeneration of the follicle is an almost uniform process in the ovaries of the guinea-pig, rat, mouse, and dog. In primordial follicles, no more than a fatty degeneration of the epithelium was observed; but degeneration may befall all other follicles, especially those which are half ripe. The process usually begins with the destruction of the ovum; then the epithelium degenerates; before the latter disappears there is remarkable proliferation in the theca.

The zona of the ovum seems to become swollen and hyaline; the yolk undergoes fatty degeneration; the germinal vesicle is subjected to chromatolysis. Hints of irregular processes of nuclear division are observed, but Schottlaender saw only two figures which could be regarded as "directive." The granulosa cells migrate into the yolk, which degenerates completely and is absorbed. The epithelium degenerates in various ways:—the chromatin of its nuclei is destroyed and the cells become smaller and paler, or the cells undergo fatty degeneration without chromatolysis, or both processes are combined. Before ovum and epithelium are finally dissolved, the theca proliferates. A layer of connective tissue with blood-vessels and with fat sinks into the follicular space, but this layer varies considerably according to the age of the follicle and in different animals. What relation this connective-tissue body, which marks the disappearance of a follicle, may bear to the appearance of its successor, is still unknown.

β. Histology.

Attraction-Spheres and Central Bodies in Tissue and Migratory Cells.†—Prof. W. Flemming, referring to the few observations that have

* Arch. f. Mikr. Anat., xxxvii. (1891) pp. 192-238 (2 pls.).
† Anat. Anzeig., vi. (1891) pp. 78-81 (5 figs.).

been made in support of E. van Beneden's discovery of attraction-spheres and central bodies in cells, offers something to fill the lacuna. In the leucocytes of *Salamandra* he has found radiate spheres and central bodies when mitosis was not going on. And he has especially devoted himself to the study of very flat cells. As a result he has found the central bodies, not only in early stages, but in resting cells. In fixed cells they are small, but in leucocytes a good deal larger. If treated with safranin, gentian, and orange they are, in the former, only visible by their slight red coloration, and if the cells have been exposed too long to alcohol they cannot be seen at all. In leucocytes they are nearly always recognizable, on account of their size and rather high refractive power. The relation of the central bodies to the nucleus in fixed cells is generally this: they lie on a longitudinal side of the nucleus when this is of an elongated form, and when the nucleus is kidney-shaped they are found on the concave side; but these relations are not constant.

Although it is only rarely that these bodies are seen, Prof. Flemming believes that they may be always present. Their invisibility may be due to various causes. If they are not at the edge of the nucleus, but a little above or below its surface, they are hidden; the colour may be extracted from one and remain in another; the slightest darkening above or below them may cause them to be invisible; and, lastly, they may be too small in any given cell to be seen by means that have been used to observe them.

The author finds the central bodies much more often double than single, and he thinks that where only one is seen the other may be hidden. He offers these remarks as a contribution towards the confirmation of van Beneden's view that the spheres and central bodies are general and permanent organs of the cell.

Clasmatocytes.*—Prof. L. Ranvier gives to certain cells found in thin connective tissues of Vertebrata (epiploon of mammals, mesentery of Batrachia) the name of clasmatocytes (κλασμα, a fragment). They are demonstrated by stretching the membrane on a slide, and then pouring over it a few drops of one per cent. osmic acid. After two or three minutes it is washed with distilled water, and stained with a dilute solution of BBBBB methyl-violet, one part of the concentrated solution to ten parts of distilled water. After putting on a cover-glass the preparation is examined with medium powers, and the clasmatocytes are seen as branched or moniliform cells stained a red-violet. In their immediate neighbourhood, and especially about their prolongations, are to be seen accumulations of granules, a condition which the author supposes to be characteristic of these cells, and hence their name. Although these cells are derived originally from leucocytes they are quite immobile, and hence resemble extremely the macrophages of phagocytosis.

Transformation of Lymphatic Cells into Clasmatocytes.†—M. L. Ranvier has been able to watch in a glass the conversion of lymphatic cells into those modified migratory cells which he calls clasmatocytes.

* Comptes Rendus, cx. (1890) pp. 165–9. † Op. c., cxii. (1891) pp. 688–90.

He placed in a glass cell a drop of peritoneal lymph of the frog, collected by means of a sterilized pipette. When the glass cover is added care must be taken to leave a little air round the lymph. If the examination be made at 15°, the amœboid lymphatic cells, which are among the cells present, will be found to exhibit very lively movements. Most sink to the bottom, where they attach themselves to the glass, extend themselves, and become so delicate that they will disappear from the observer unless closely followed. At this stage they are very active, and multiply pretty rapidly by direct division. If the temperature be raised for one hour to 25°, some of the lymphatic cells which have given off arborescent prolongations more or less long and complex will be found immobile. To observe the structure of these clasmatocytes, M. Ranvier has fixed the elements with osmic acid, and stained them with violet 5 B or hex-ethyl violet, or he has fixed them with picric acid and stained with hæmatoxylin, and then eosin. It is only in fixed preparations that the varied, complicated, and often sharp forms of the clasmatocytes can be properly appreciated.

Two Kinds of Chromatin.*—Prof. L. Auerbach finds that "chromatin" includes two kinds of substances, which stain in different ways and react differently to chemicals. The so-called "achromatin" consists for the most part of material belonging to one of the two chromatin substances. As one of these has a greater affinity for eosin, fuchsin, aurantia, carmine, and picrocarmine, while the other has a greater affinity for methyl-green, anilin-blue, and hæmatoxylin, Auerbach proposes to call them erythrophil and cyanophil respectively. In studying these two substances he has been confirmed in his conclusion that the presence of an intra-nuclear network is casual and of secondary importance, not a fundamental fact of structure. The network sometimes seen is due to a modification of the cyanophil, or less frequently of the erythrophil, or sometimes even of both, for a double network may occur. The erythrophil resembles the protoplasm of the cell-substance more than the cyanophil does. The latter has amœboid mobility; it forms the nuclear membrane when that is karyogenic or produced by the nucleus, and not cytogenic or produced by the cell-substance.

Red Blood-corpuscles of Amphibians.†—Prof. L. Auerbach gives a precise account of these cells so often observed. They have a distinct cell-membrane. The cell-substance is divided into a cortical layer and a medullary substance. In adults there are normally many nucleoli in the nucleus. An apparent homogeneity of the nucleus often results from the method of examination, while a reticulate structure may be produced in certain conditions by modifications of the nucleoli.

Nature and Varieties of Leucocytes.‡ — Dr. G. Lovell Gulland has prepared a critical and historical account of the varieties of leucocytes, which should be useful to those who are interested in the subject.

Evacuation of Cell-nuclei.§—Dr. R. Blanchard reports that he kept a specimen of *Proteus anguineus* with the object of studying its parasites.

* SB. K. Preuss. Akad. d. Wiss. (1890) pp. 735–49.
† Anat. Anzeig., v. (1890) pp. 570–8 (2 figs.).
‡ Rep. Lab. R. Coll. Physicians Edinb., iii. (1891) pp. 106–56 (1 pl.).
§ Bull. Soc. Zool. France, xvi. (1891) pp. 22–3.

As it was evacuating elliptical corpuscles he imagined that these were the eggs of a nematode, and that there was a nematode within. However, on dissection, not a parasite was found. Nor were the corpuscles coccidia. Maceration of the walls of the intestine showed that the bodies were the nuclei of mucus-producing cells; the cells become destroyed in consequence of their activity, and the nuclei escape in consequence of being protected by an envelope.

Structure of the Spinal Cord in Human Embryos.*—Prof. A. von Kölliker finds in the spinal cord of human embryos a corroboration of his conclusions in regard to that of other mammals. The fibres of the sensory roots divide as they enter the cord into an ascending and a descending branch; the longitudinal fibres of the strands in the cord give off collateral fibres which ramify in the grey matter and end in tufts; the anterior commissure is clearly seen in the neck and loin regions as a crossing of fibres, most of which arise from the axial processes of cells in all parts of the grey matter; these do not pass, as regards the commissure, into root-fibres, but into longitudinal elements of the anterior and antero-lateral strands. Sections prepared according to Golgi's method of staining, differentiate the elements as effectively as do those of Flechsig, and Weigert's method is also satisfactory.

Optical Characters of Medullated and Non-medullated Nerve-Fibres.†—Herr H. Ambronn demonstrated, in 1888, that the optical peculiarities of cork and some other vegetable tissues were due to crystalline particles of a wax-like substance. As medullated nerve-fibres differ optically from muscle, sinew, &c., as cork differs from most vegetable tissues, it seemed likely that the refraction peculiarities of medullated fibres were also due, as Klebs and Kühne suggested, to crystalline particles. By careful experiments, Ambronn convinced himself that the body to which the nerve owes its optical peculiarities is lecithin. This conclusion Gad and Heymans have corroborated in another way. According to Ambronn, the substance, both of medullated and non-medullated fibres (apart from Schwann's sheath), shows, in the absence of myelin or lecithin, the normal positive double refraction. If the lecithin be present in the form of very small crystals, with their optical axes radially and uniformly arranged, the positive double refraction of the matrix will be disguised; the opposite character will appear to a degree varying with the quantity of lecithin. But the use of ether will always bring out the positive character of the matrix-substance, and the optical change affords an index to the quantity of lecithin present.

Histology of Spermatozoa.‡—Mr. G. Dubern, working with a quarter and an eighth, and very intense sources of light, has discovered that the head of the human spermatozoon is composed of a number of closely set minute spheres, and that the tail is composed of thirty-five to forty small spheres, "very much like the beads of a single-row necklace." The wide generalizations that these and other observations have induced the author to formulate will be found in the author's paper.

* SB. Physik.-med. Gesell. Würzburg, 1890, pp. 126–7.
† Verh. K. Sächs. Gesell. Wiss., 1890, pp. 419–29.
‡ Indian Med. Rev., ii. (1891) pp. 30–6.

γ. General.

Plankton-Studies.*—Prof. E. Haeckel begins his account of plankton-studies with an historical sketch, in which the first date is 1845, when Johannes Müller began his memorable "pelagic fishing with a fine net." From him Haeckel and many others received their first impulse. After recording the various plankton studies conducted by himself and others, Haeckel draws a number of distinctions between Plankton and Benthos, Plankton and Nekton, Haliplankton and Limnoplankton, and so on. "Plankton" was originally defined by Hensen as including those animals which drift in the sea.

The plankton organisms are classified as follows :—

A. Protophytes: Chromaceæ, Calcocyteæ, Murracyteæ, Diatomeæ, Xanthelleæ, Dictyocheæ, Peridineæ.
B. Metaphytes: Halosphæreæ, Oscillatoriæ, Sargasseæ.
C. Protozoa: Infusoria, Foraminifera, Radiolaria.
D. Cœlenterata: Medusæ, Siphonophora, Ctenophora.
E. Helminths: Chætognatha.
F. Mollusca: Pteropoda, Heteropoda, Cephalopoda.
G. Echinodermata: larvæ.
H. Articulata: Annelids like *Tomopteris* and *Alciope*.
Crustaceans such as Copepods, Ostracods, Schizopods.
Insects, Halobatidæ.
J. Tunicata: Copelata, Lucidiæ, Thalidiæ.
K. Vertebrata: e. g. ova and larvæ of fishes.

Haeckel then discusses the sometimes homogeneous, but oftener heterogeneous character of the plankton; its annual, monthly, daily, and hourly variations; the difference in quality in different climatic zones, the influence of currents; the methods of study. Throughout there is vigorous criticism of Hensen's plankton studies.

Position of Nerve-Centres.†—M. A. Julien is of opinion that nerve-centres may be reduced to three types: the ventral (of Radiates), the dorso-ventral (of Annelids and Mollusca), and the dorsal (of Vertebrates). He formulates a general biological law in the following terms:—There is a constant relation between the position of the principal nerve-centres and that of the chief sensory and locomotor organs. Thus, in Asteroids, the locomotor system is formed by a circular canal which is placed around the mouth, and gives rise to five ventral canals; each of these canals carries tactile organs, and is often terminated by a visual organ. The circumanal canal is in relation with a nerve-ring, which gives rise to five ambulacral trunks. Illustrations are given explaining how this law may be applied to the other groups cited; a physiological explanation of the anatomical law is offered, and the corollary urged that the Vertebrate is not an Annelid on its back, or *vice versâ*.

Protoplasm and Life.‡—Under this title Mr. C. F. Cox has published a critical and historical essay on "protoplasm and the cell-doctrine,"

* Jenaische Zeitschr. Naturwiss., xxv. (1890) pp. 232–336.
† Comptes Rendus, cxii. (1891) pp. 741–3.
‡ New York, 1890, sm. 8vo, 67 pp.

and on the relation of the spontaneous generation theory to the general theory of evolution. We have not noted any new facts in it.

B. INVERTEBRATA.

Action of Nicotin on Invertebrates.*—Miss M. Greenwood has made a study of the effects of nicotin on certain Invertebrates. The toxic effect on any organism is mainly determined by the degree of development of the nervous system. For *Amœba* or *Actinosphærium* it cannot be regarded as paralysing; it is rather inimical to continued healthy life. The higher forms show that the nervous actions which imply co-ordination of impulse are the first to be stopped. In the Medusæ spontaneity, irradiation of impulse, and direct motor activity are affected successively. In still higher forms the paralysing action of nicotin is preceded by a phase of stimulation; this becomes marked in Ophiurids and Crinoids, and is very characteristic of the poisoning of *Palæmon* and *Sepiola*.

As this positively exciting action becomes noticeable, nicotin becomes more and more a medium in which life is impossible. For example, *Amœba* is not killed at once by a 1 per cent. solution of nicotin tartrate. *Hydra* dies rapidly in such concentration, but will live overnight in ·05 per cent.; such a solution kills *Lumbricus*, which tolerates ·01 per cent. for only a few hours. ·05 per cent. solution paralyses *Asterias* and *Antedon* in half an hour; ·005 per cent. in less than a minute so injures *Sepiola* that there is no subsequent recovery.

When very simple animals die under the action of nicotin death is often associated with injury of their substance so that it tends to disintegrate. The definite poisoning that occurs in higher types has sometimes, as one of its after-effects, a lingering trophic disturbance. An extreme case is presented by *Palæmon*, where there may be a progressive death of tissues from behind forwards.

Notwithstanding the general relation of the action of nicotin to the stage of development of the nervous system, there is an appreciable amount of difference in animals placed near one another in systematic classifications.

The Trochozoa.†—M. L. Roule proposes a new phylum of the Cœlomata to include some worms, the Mollusca, Bryozoa, and Brachiopoda. Its systematic position may be seen from the following table:—

Cœlomata	Vermes	Platyhelminthes	
		Nemathelminthes	
		Trochozoa	
	Arthropoda	Arthropoda	
	True Enterocœlia ..	Chætognatha	
		Echinodermata	
		Hemichordata	
		Urochordata	
		Vertebrata	

The Trochozoa are characterized by the constant appearance (except in cases of abbreviated development) of a larva which belongs to the

* Journal of Physiology, xi. (1890) pp. 573–605.
† Ann. Sci. Nat., xi. (1891) pp. 121–78.

trochophore type; it is characterized by more or less numerous rings of cilia, one of which (the oral corona) is placed at the level of the mouth, and is remarkable by its persistence; by a mesoderm derived from a small number of initial cells (often two), and by a schizocœlic cœlom; the Brachiopoda alone form an exception to this rule; and by a pair of excretory organs or cephalic nephridia which appear very early in the course of development.

The first subdivision is that of the Polymeria; in them the mesodermal stripes early give rise to dissepiments which divide the cœlom into segments. The first series is that of the *P. intacta* or Annelids, among which we have the Archiannelids, achætous Euannelids, represented by the Hirudinea, and the Chætopodous Euannelids. The *P. distincta* or Pseudannelids are represented by the Sternaspidia and Gephyrea. The second subdvision is that of the Monomeria, in which there is a simple cœlom, or one divided into sinuses. Here we have the Rhyncota or unarmed Gephyrea, the Brachiata or tubicolous Gephyrea, of which *Phoronis* is a type, the Bryozoa, the Brachiopoda, the Velata—or our old friends the Rotifers, the Amphineura, and the Mollusca; of these last the Solenoconcha form the subtype of Premollusca, while Lamellibranchs, Gastropods, Pteropods, and Cephalopods unite to form the Eumollusca or true Mollusca. It is not for us to apologize for the numerous hybrid names proposed in this memoir.

Abnormalities in Crayfish and Earthworm.*—Dr. W. B. Benham reports an observation on a Crayfish in which, with normal ovary, there were two oviducts on either side, one of which opened on the 11th and the other on the 13th appendage; there were no indications of hermaphroditism. This, in conjunction with other facts, points to the possibility of a pore and a duct for each of the last three ambulatory appendages. It is possible that Arthropods had originally a pair of nephridia in each segment; in the Crustacea most of these are suppressed, but those of the second antennary segment and of the second maxillary remain, and with these three would help to fill up the series.

Of several thousands of common earthworms examined by Dr. Benham only one case of asymmetry has been observed. In this the genital orifices of the right side were on the 13th and 14th segments, instead of on the 14th and 15th as on the left side and in normal earthworms. On the right side there was only one spermatheca and two sperm-sacs, while the ovary was in segment xii. instead of xiii.; the calciferous gland was also absent from the right side of segment xii.

Mollusca.

Census of Scottish Land and Freshwater Mollusca.†—Mr. W. D. Roebuck summarizes the records of Land and Freshwater Mollusca which have so far been authenticated from Scotland; these records are comparatively small. In all 103 species are registered. This list should be very useful to Scottish naturalists.

* Ann. and Mag. Nat. Hist., vii. (1891) pp. 256–8 (1 pl.).
† Proc. Roy. Phys. Soc. Edinb., 1889–90 (1891) pp. 437–503.

γ. Gastropoda.

Anatomy of 'Hirondelle' Gastropods.*—M. E. L. Bouvier gives us the first of a series of studies on the Gastropoda collected during the voyage of the Prince of Monaco. He now deals with the relations of the arterial circulatory apparatus to the nervous system.

In the Prosobranchiata the aorta bifurcates almost immediately after leaving the ventricle; its posterior branch plunges into the viscera, while the anterior passes under the supra-intestinal branch of the visceral commissure; in the front part of the body it passes above the œsophagus, goes through the cerebro-pedal and pallio-pedal collars with it, and then divides into several branches unequal in importance.

In the Pulmonata—e. g. *Lymnæa stagnalis*—the visceral chain is elongated and its ganglia are well separated from one another; after reaching the anterior part of the body by passing above the œsophagus the anterior aorta passes below the visceral chain, then above the pedal commissure, and then divides almost as in the Prosobranchiata.

Very great differences are exhibited among the different representatives of the Opisthobranchiata. In *Bulla hydatis* the anterior aorta runs parallel to the right branch of the visceral commissure, and when it has reached the level of the pedal ganglion it gives off a cephalic artery, and then passes transversely in front of the great anterior pedal commissure. About the level of the middle of this commissure it gives off a labial and a buccal branch, and, then, on the left forms a cephalic and a recurrent pedal artery. *Scaphander lignarius* and *Philine aperta* show much the same relations. In *Aplysia* the anterior aorta passes under the right branch of the visceral commissure, above the "parapedal" and below the pedal and subcerebral commissures. Differences are again found in *Doris*, *Eolis*, and *Tritonia*.

Development of Paludina vivipara.†—Herr R. v. Erlanger finds that the mesoderm of *Paludina vivipara* begins to appear soon after the formation of the gastrula as a tubular outgrowth of the archenteron. This soon becomes constricted off from the gut, and takes on a semilunar form, in the cavity of which the gut lies. As the cœlomic sac gives rise to parietal and visceral lamellæ it surrounds the whole of the intestine. The mesoderm finally breaks up into the well-known spindle-shaped cells which traverse the cœlom in a very irregular fashion.

The pericardium is derived from the cœlom, and appears at first paired. Soon a small evagination of the wall is seen in the left portion, and a little later a somewhat larger one appears in the right. The latter forms the permanent kidney, while the former corresponds only to a rudimentary left kidney. The pallial cavity appears as a ventral ingrowth of the ectoderm just below the pericardium.

While these processes are going on all the organs found within the now formed shell undergo a change in position. Thus the pericardium, which was at first ventral and set perpendicularly to the long axis, passes altogether to the right half of the body. The heart is formed as an invagination of the hinder wall of the pericardium. This invagination forms an elongated groove, which soon becomes converted into a tube

* Bull. Soc. Zool. France, xvi. (1891) pp. 53–6.
† Zool. Anzeig., xiv. (1891) pp. 68–70.

which is connected anteriorly and posteriorly with the pericardiac wall, and remains open so as to allow of a communication between the lumen of the heart and the cœlom. The cardiac tube becomes very early constricted in its middle, the auricle appearing in the anterior and the ventricle in the posterior half. The blood-vessels are formed from lacunar spaces of the cœlom, which are inclosed by mesoderm cells. They soon become connected with the heart. All the ganglia are formed by delamination from the ectoderm, and arise independently of one another. The ventral ganglia appear in the velar area under the rudiments of the tentacles, and the buccal ganglia from the ectoderm of the œsophagus. The intestinal ganglia are formed on either side of the middle of the body, but are soon twisted, one above and the other below the intestine. The visceral ganglion is developed in the ectoderm of the pallial cavity.

The primitive kidney is formed on either side from a mass of mesoderm cells in which a cavity soon appears. The saccules grow out into a tube, one end of which reaches to the surface and breaks through the ectoderm. The opposite end becomes ciliated internally, but it is not certain that it has an internal orifice.

Anatomy of Corambe testudinaria.*—M. H. Fischer gives an account of the anatomy of this recently described species of Nudibranch. On account of the peculiarities which it presents, the author thinks it is more nearly allied to the Anthobranchiata than to the Polybranchiata; it has, however, some resemblances to the Phyllidiidæ.

The embryo, at the moment of extrusion, has the pigmented body which has been described in *Philine* as the anal eye.

Hepatic Epithelium of Testacella.†—M. J. Chatin has studied the minute anatomy of the so-called liver of *Testacella haliotidea*. He finds that the tubes of this organ are lined by large, depressed cells, intermediate in form between the cubical and the pavement cells. They vary in size, and have no proper membrane; a slight differentiation of the protoplasm can just be made out at their periphery. The protoplasm itself is reticulated and spongy, and between the bars there is a less refractive fluid substance in which there are granulations. Some of these last are brilliant and colourless, while others are yellowish or brownish.

Among these cells there are others which are smaller, have a large nucleus, and an almost homogeneous protoplasm; these appear to be young cells, ready to replace the older ones.

Intermediate stages can be made out between the flattened cells of the cæca, and the elongated cells of the canals of which the organ is composed; and this gland in *Testacella* may be cited as one which offers every intermediate stage between mosaic and palisade epithelium, which are usually regarded as profoundly different. The author concludes by insisting on the value of researches in Zoological Histology.

Heart of Dentalium.‡—Dr. L. Plate finds that Lacaze-Duthiers was in error in denying the existence of a heart in *Dentalium*. It is present,

* Comptes Rendus, cxii. (1891) pp. 504-7.
† T. c., pp. 493-4.
‡ Zool. Anzeig., xiv. (1891) pp. 78-80.

though rudimentary, and is lodged in a special pericardium. It has the form of a rounded, thin-walled bag, and is not divided into two chambers. This simple structure, the complete absence of vessels with proper walls and of renopericardial orifices, are signs of degeneration. The heart is nothing more than a saccular invagination into the lumen of the pericardium of part of the dorsal pericardial wall. The blood-corpuscles enter the heart by narrow clefts, which lie between the stomach and the dorsal pericardial wall, and they leave it by similar spaces between the wall and the kidney. The minute structure of the wall of the heart is the same as that of the pericardium, and in both there are numerous muscular filaments set circularly and parallel to one another.

δ. Lamellibranchiata.

Blood of Lamellibranchs.*—Dr. H. Griesbach has investigated the blood of fifty-five bivalves with the following result. The red pigment of several (e. g. *Poromya granulata*, *Solen legumen*, *Tellina planata*, *Arca Noæ*, *Pectunculus glycimeris*) is hæmoglobin, or very nearly allied to it. The pigment is diffused in special disc-like or spherical cells which have a distinct membrane, a finely striated structure, a nucleus and nucleolus. The leucocytes are clear or granular, and consist of a spongy framework with more unstable material in the meshes. When alive they do not take up pigment injected into the blood, until they have lost their normal characteristics. In the intact cells there are no vacuoles. The unstable material forms long pseudopodia, which are insheathed for some distance by the firmer spongy substance. By these processes the leucocytes are never united to one another. The contractile substance is limited by a "plasma-membrane," which is readily affected by abnormal conditions. All the leucocytes have a distinct nucleus, which lies in a "free space," contains two chemically different substances, and has no definite reticulate structure, nor any nuclear membrane. No processes of division were observed. The blood of some Lamellibranchs contains crystals, which effervesce when an acid is added. The varied movements of the leucocytes as observed in artificial conditions are in great part the results of abnormal physical and chemical influences. When water enters the system the pigmented and unpigmented cells are abnormally affected—a fact which Griesbach uses as an argument against the supposition that water may enter the blood during normal life.

Lepton squamosum.†—The Rev. Dr. A. M. Norman has an interesting note on this Mollusc, which he shows to be a commensal. While digging at Salcombe he observed that wherever the long passages formed by *Gebia stellata* were still occupied by the living Crustacean, the *Lepton* was to be found near. The burrows of the *Gebia* are lined with an ochreous-coloured slimy deposit, upon which it is probable that *Lepton* feeds. The geographical range of the Crustacean and the Mollusc appears to be the same, and similar observations by Stimpson on the Floridan *Lepton loripes* confirm the view that we have here to do with a case of commensalism; as does also a specimen found at Puget Sound.‡

* Arch. f. Mikr. Anat., xxxvii. (1891) pp. 22–99 (2 pls.).
† Ann. and Mag. Nat. Hist., vii. (1891) pp. 276–8. ‡ T. c., p. 387.

The extraordinary compression of the shell of *L. squamosum* is now intelligible; it lies flat on the floor of the passage and is not injured or affected by the *Gebia* as it scuttles in and out.

Entovalva mirabilis.*—Under this name Dr. A. Voeltzkow describes a parasitic Lamellibranch found in the intestine of a *Synapta*. When removed from its host the creature moves about actively by means of its large foot, on which there is a small sucker; the shell is small, and the whole length is from two to three millimetres.

When the animal is extended, about one-third of the body is covered by the shell, and when it is irritated the whole of it cannot be drawn into this shell. The mantle incloses the shell-valves completely, is fused along the middle line in its lower part, and leaves only a small slit for the passage of the foot. At one end it is continued into a bell-shaped enlargement; this last has strong walls, is hollow interiorly and is only traversed by a few muscular fibres; like the foot, it is in constant movement. The author gives a few anatomical details as to various organs; the mollusc is hermaphrodite, and he has been able to observe some of the stages of development. No indications are given as to the systematic position of this endoparasite.

In a postscript there are a few notes on a Gastropod also found parasitic in the same species of *Synapta*; it would appear to be different from the parasitic species of *Entima* discovered by Semper.

Molluscoida.

α. Tunicata.

Blastogenesis of Astellium spongiforme.†—M. A. Pizon finds that the newly hatched larva possesses only two ascidiozooids, and not three as Giard described. The larva consists of the primitive oozoid with its sensory vesicle, a primary blastozooid, and a brown mass which Giard regarded as the intestine of a second blastozooid. But there is no trace of a second branchial sac; the brown mass diminishes and disappears within 24 hours after hatching; even after four days there are still only two ascidiozooids. This agrees with what Macdonald described in the closely related *Diplosoma Rayneri*, and with Lahille's description of *D. Koehleri*. The ectodermic tubes in the mantle of each ascidiozooid are not transformed into new individuals; the five or six blastozooids which Giard described on larvæ which had been fixed for seven or eight hours do not exist. A short diverticulum from the peribranchial membrane of the first blastozooid and a slight thickening of the peritoneal membrane were recognized as the two rudiments of the second blastozooid of the young colony.

Budding of Larva of Astellium spongiforme and Pœcilogony in Compound Ascidians.‡—M. A. Giard, referring to the work of M. Pizon on *A. spongiforme*, points out that he has failed to observe that in the Synascidiæ the development and number of blastozoites produced by one egg very often largely depends on etiological conditions. M. Giard has himself already insisted on this, and Lahille has given a striking

* Zool. Jahrb. (Abth. f. Systematik, &c.), v. (1891) pp. 619–28 (1 pl.).
† Comptes Rendus, cxii. (1891) pp. 166–8. ‡ T. c., pp. 301–4.

demonstration of it in *Leptoclinum Lacazii*, where ova of two kinds may be found in one colony.

The cases presented by Synascidians are not isolated in the Animal Kingdom; differences of development in *Aurelia aurita* have been observed by Haeckel and by Schneider; *Ophiothrix fragilis* may deposit eggs which give rise to perfect or imperfect plutei or even to embryos which cannot swim and which go through a direct development. Both the author and Dr. Boas have shown that the size and number of the eggs, and the rapidity of metamorphoses in *Palæmonetes varians* are not the same in northern salt as in southern fresh waters. And, finally, Portschinski has discovered that *Musca corvina* has completely different eggs and larvæ near St. Petersburg and in the south of Russia. These phenomena the author proposes to unite under the name of pœcilogony.

Development of Distaplia magnilarva.*—Dr. M. v. Davidoff now gives an account of the general developmental history of the germinal layers of this compound Ascidian. The various parts of his subject are dealt with in the following order:—I. Segmentation and Gastrulation: 1. The first three stages of segmentation; 2. Further segmentation-stages as far as the development of the Plakula-form; 3 Gastrulation and the formation of the fore-gut; 4. Comparative survey of the gastrulation of Ascidians—*a.* The relation of the gastrulation of *Distaplia* to that of other Ascidians; *b.* Remarks on the development of the bilateral plan of structure in Ascidians; *c.* On the relation of the axis of the gastrula to the body-axes in Ascidians; and *d.* Some remarks on Rabl's phylum of Vertebrates. II. Development of the mesoderm: 1. In *Distaplia;* 2. In *Clavillina Rissoana;* 3. In the simple Ascidians; 4. Comparative remarks on the origin of the mesoderm in Ascidians. III. On the formation of the gastric endoderm and of the chorda dorsalis: 1, 2, and 3 as in II. and 4. Comparative remarks. IV. On the development of the nervous system: 1. In Ascidians in general. 2. Comparative remarks on the nervous system of the Ascidians. V. On the separation of the tail-rudiment from the trunk.

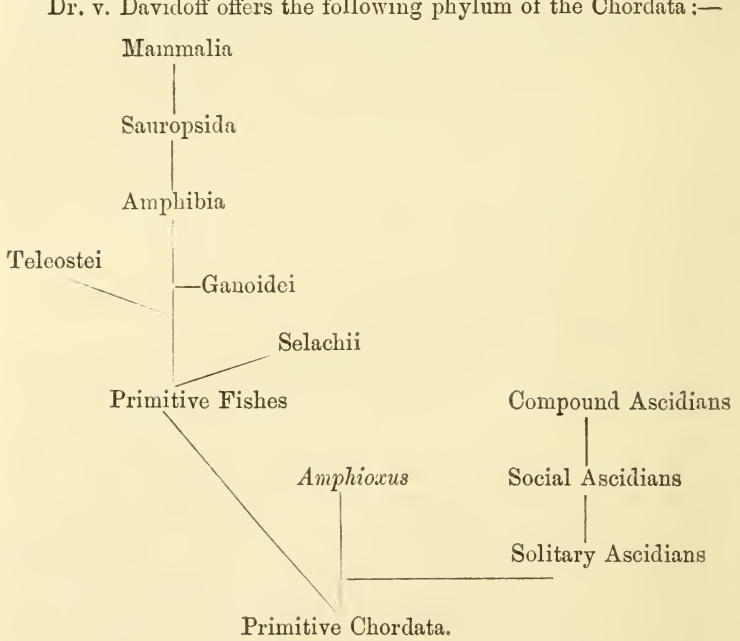
As far as the stage of four blastomeres segmentation in *Distaplia* is equal. The single asymmetrical phenomenon up till then observed is the excentric position of the cleavage-nucleus, which is retained unaltered in the nuclei of the first four cleavage-spheres. When the embryo becomes oval in form two endodermal cells remarkable for their small size may be seen at the hinder end; these are not only characteristic of the hinder end, but are the first rudiments of the nerve-ring.

After the completion of gastrulation the embryo remains for some time as a solid structure without any internal cavity. When a dorsal groove is formed its floor consists exclusively of endodermal cells. In simple Ascidians the early stages of development are of one type; cleavage is always equal and there is a more or less well-developed cleavage cavity which, sooner or later, becomes reduced to a cleft and, finally, completely disappears. The endoderm is formed by an invagination and leads to the formation of an archenteron, the primitively wide orifice of which (blastopore) narrows from before backwards in such a way that it disappears latest posteriorly. In social Ascidians there are

* Mittheil. Zool. Stat. Neapel, ix. (1891) pp. 533-651 (7 pls.).

conditions which approximate to the mode of development of compound forms (*Distaplia*); the cleavage cavity is greatly reduced, and may even be wanting; in consequence of this there is no true invagination, and emboly is converted into pseudemboly. The result of cleavage is a bilaminate plakula; the gastrula is formed by folding, the edges of the plakula rising up and growing towards one another; this pseudemboly is due to the unequal growth of the cells of the two germinal layers. In the development of compound Ascidians we go further, for the archenteric cavity is not formed either by emboly or pseudemboly but by delamination in the interior of the endodermal cell-complex. The overgrowth of the endoderm by the ectoderm in *Distaplia* is not effected in the same way along the whole length of the embryo; anteriorly it is purely epibolic, but posteriorly the dorsal endoderm-cells unite with the adjoining ectoderm-cells to grow round a space (pseudo-gastrula-pit) which is, later on, filled up by endodermal cells. This must be regarded as a rudimentary emboly which, notwithstanding its degeneration, typically repeats the conditions which obtain in social Ascidians. From this it is clear that the mode of development of Ascidians is parallel to the phylogenetic relations of their several orders.

Dr. v. Davidoff offers the following phylum of the Chordata:—



In the study of the development of the mesoderm the author finds it necessary to distinguish the mesoderm of the epibolic part of the embryo of *Distaplia* (pregastric mesoderm) from that of the pseudembolic portion (gastric mesoderm), The elements of the latter appear early, and are derived from ventral parts of endoderm-cells; they may be known as mother-cells or gonads of the gastric mesoderm. When pseudemboly is

completed the mesoderm-gonads lie below the nerve-plate; posteriorly they take part in the formation of the chorda dorsalis. They give rise to mesodermal elements, but remain themselves true endodermal cells. The gastric mesoderm is developed bilaterally, and becomes divided into the somatic and caudal mesoderms. The latter persists as a solid rudiment and becomes converted into the muscular layer of the tail, while the former is gradually lost in the mesenchym.

The pregastric mesoderm arises much later from the cells of the pregastric endoderm that lie in front of the intestine; it becomes gradually converted into mesenchym-cells, which agree in all points with those of the gastric mesoderm. The somatic and pregastric mesoderm unite, finally, into a common tissue, the body-mesenchym. It is to be specially noted that no signs of segmentation are to be seen in the gastric mesoderm, and in the caudal there is no indication whatever of a cavity comparable to a myocœlom.

The history of development seems to show that neither *Amphioxus* nor the Ascidians are derived from ancestors which can be supposed to have been Enterocœlia.

The development of the medullary tube of *Distaplia* is not so simple as might have been supposed. Three parts have to be distinguished, two of which belong to the pseudembolic, and one to the epibolic region. Posteriorly, in the region of the future tail, elements of the nerve-plate enter into the formation of the medullary tube, but more anteriorly ectodermal cells form covering cells for the medullary tube, and only much later become differentiated into nerve-cells. From the epibolic portion of the embryo the medullary tube obtains an increase in material which forms the anterior wall of the future sensory vesicle, and is not developed in the ordinary way; the ectodermal cells multiply and give rise to a uni- or bilaminate rudiment, which is overgrown from the sides by ectodermal cells.

Amphioxus and the Ascidians are distinguished from Vertebrates by the fact that in the last the medullary plate closes from before backwards, and not in the opposite direction as in them. It is not yet quite clear which is the more primitive of these two modes of development.

β. Bryozoa.

British Species of Crisia.*—Mr. S. F. Harmer has come to the conclusion that the British fauna includes more species of the genus *Crisia* than are generally recognized; this result is based on a comparison of the ovicells, and especially of their apertures. He finds that the essential characters of the ovicells are extremely constant, in spite of the occurrence of variations of no inconsiderable magnitude in other parts of the colony.

The author thinks that it is necessary to pay careful attention both to the number of zoœcia in the individual internodes and to the character of the branching, and he has devised a method of graphic representation to show these points in each species.

C. denticulata Lamk., *C. eburnea* Linn., *C. aculeata* Hassall, *C. ramosa* sp. n. (from Plymouth) are diagnosed.

* Quart. Journ. Micr. Sci., xxxii. (1891) pp. 127-81 (1 pl.).

The author gives the results of his observations on the habit of the zoarium at different seasons, on regeneration, and on the mode of branching of the different species. At Plymouth the dominant species is *C. ramosa*, which is particularly fond of growing on stones. *C. eburnea*, which is also common at Plymouth, is always found on red seaweeds or on *Sertularia*.

Marine Polyzoa.*—The Rev. T. Hincks, in continuation of his contributions to a General History of Marine Polyzoa, describes some, chiefly South African, and with this concludes the first series of the "Contributions," so far as the descriptive portion is concerned. *Flustra nobilis* sp. n. is a handsome species, in which the zoœcia are of unusual size; when they are furnished with forked lateral spines their appearance is very picturesque. The genus *Adeonella* cannot be separated from *Adeona*. In *Mucronella aviculifera* sp. n. the avicularia are not only profusely present, but some are large and spatulate, while most are minute in size and mounted on the top of a calcareous column or erect spine-like process.

γ. Brachiopoda.

Development of Brachiopoda.†—Mr. C. E. Beecher points out that, so far as he has studied them, all Brachiopods have a common form of embryonic shell which may be termed the protegulum. It is semicircular or semi-elliptical in outline, and has no hinge area. The modifications exhibited appear to be due to accelerated growth, by which characters primarily neologic become so advanced in the development of the individual as to be finally impressed upon the embryonic shell. The structure of the protegulum has been described as corneous and imperforate. *Kutorgina* seems to preserve throughout its development the main features of the protegulum. The greatest departure from the normal is exhibited in the most variable and specialized valve, the pedicle valve.

Variation is also to be seen in the length and direction of the pedicle and in the position and structure of the pedicle opening. A long pedicle accompanies elongate shells with short hinges, while a short pedicle causes extended hinge-growth when the plane of the valves is ascending and vertical, but a discinoid form when the plane of the valves is horizontal.

The author proposes to divide the Brachiopoda into the Atremata, Neotremata, Protremata, and Telotremata.

Arthropoda.

Striated Muscles of Arthropoda.‡—Prof. O. Bütschli and Herr W. Schewiakoff have investigated afresh the minute structure of the transversely striated muscles of Arthropods. The objects of investigation was the thoracic muscles of *Scolopendra* sp. and *Lithobius forficatus*, the cephalothoracic and chelar muscles of *Astacus fluviatilis*, and the wing-muscles of *Lucanus cervus*, *Hydrophilus piceus*, and some other insects.

Every muscle-cell is found to consist of two different kinds of protoplasm—a contractile or fibrillar substance, which forms the contractile

* Ann. and Mag. Nat. Hist, vii. (1891) pp. 285–98 (2 pls.).
† Amer. Journ. Sci., xli. (1891) pp. 343–57 (1 pl.).
‡ Biol. Centralbl., xi. (1891) pp. 33–9.

elements, and of ordinary protoplasm in which these elements are imbedded, the so-called sarcoglia, sarcoplasm, and intermediate substance. The contractile elements are plasmatic columns or plates set in longitudinal rows in the muscle-cell; they are rounded or flattened in form. The sarcoplasm is plexiform, and generally irregularly so; it stains with difficulty. The nuclei imbedded in it vary in number, form, and size; they sometimes lie directly on the surface of the muscle-cell, and sometimes within it. The outermost layer of the sarcoplasmic network which forms the surface of the cell, exhibits a so-called alveolar layer; it is capable of being more deeply stained than the rest, and its higher refractive power gives rise to the so-called pellicula. This last may correspond to the sarcolemma of earlier authors.

The wing-muscles of all the Insects examined exhibit a still further complication. Spherical corpuscles are imbedded in the network; they vary greatly in form and size. In living muscle-cells they appear to be homogeneous, and are highly refractive; when fixed they have a fine plexiform structure, and stain almost as deeply as the muscle-nuclei. The finer structure of the contractile elements is also plexiform and complicated. The characteristic peculiarity of transversely striated muscle cells is the differentiation in a longitudinal direction of the framework of the contractile elements.

Comparing the results of the present writers with those of their predecessors it may be said that the "primary disc" corresponds to their two transverse rows of the anisotropic portion, while the two "isotropic discs" correspond to their two transverse rows of the isotropic portion; the "intermediate disc" is the boundary between two transverse rows of this portion, and the two "secondary discs" are the boundary-lines between every two opposed rows of anisotropic and isotropic parts. The transversely striated muscles of Vertebrates appear to have essentially the same structure as those of Crustacea.

α. Insecta.

Food of the Larvæ of Insects.*—Dr. D. Levi-Morenos has studied the contents of the intestinal canal of larvæ found in the marshes of the Piave, near Belluno. The larvæ belonged to the family of Culicidæ, to *Chironomus plumosus* or some allied species. The conclusion arrived at was that the food of these larvæ consisted almost entirely of diatoms belonging to the genera *Cymbella*, *Ceratoneis*, *Odontidium*, *Meridion*, *Navicula*, &c. This is contrary to the view of Lefevre, who describes the larva of this species as carnivorous. The author points out the importance of this question in relation to pisciculture.

Odoriferous Organs of Lepidoptera.†—Dr. E. Haase has studied the odoriferous organs in Indo-Australian Lepidoptera, and of his results F. Plateau gives a terse analysis. The odoriferous organs are either defensively repellent, as in some Danaids, or sexually attractive. In some Bombycidæ, as is well known, the females attract the males from long distances; in most cases the odour of the males is attractive to the females.

Some of the odoriferous scales occur on the wings. There they are

* Neptunia, i. (1891) pp. 7-11.

† Bull. Soc Entomol. Ital., xxii. (1891) pp. 138-43.

scattered in some diurnal Lepidoptera, but a localized arrangement is commoner. They lie on the upper surface of all the wings in *Heteronympha*. They often occur on the anterior wings only:—concealed by a costal fold in *Casyapa*, *Hecatesia*, *Aganais*, &c.; on the upper surface in *Ulysses*, *Peranthus*, *Argynnis*, &c.; on the under surface in *Bizone* and *Celerena*. Often they occur on the posterior wings only:—on the anterior margin in *Patula* and *Argiva*; on the upper surface in *Eronia*, *Ideopsis*, *Danais*, *Amathusia*, *Regadia*, &c.; on the abdominal or internal area, folded upwards in *Ornithopterus pompeus* and Papilionidæ, folded downwards in Morphidæ; on the lower surface in *Plecoptera*. Moreover in many Lepidoptera the parts of the wings which rub against each other in flight bear complex combinations of odoriferous scales and hairs.

But in *Chærocampa* the odoriferous organs are thoracic; in most Sphingidæ and Agaristidæ and in some Noctuidæ they are abdominal; in almost all Danaidæ and in many others they lie near the genital aperture. Finally, the organs may lie on the palps (in *Bertula*), or on the appendages, as in *Ismene*, *Caprila*, *Hyblæa*, and many others.

Development of Nervures of Wings of Butterflies.*—Dr. E. Haase has made an examination of the development of the neuration of *Papilio Machaon*. He finds that the so-called costa of the forewing is only a marginal thickening, but that all the other nervures are formed by tracheæ. The whole trunk of the latter becomes a concave or a branched convex nervure or some branches become convex and others concave nervures. The so-called convex folds in the middle cell of the wing are the remains of radial and median tracheal trunks, as van Bemmelen has already shown for the Nymphaliidæ. As in the Trichoptera three median trunks become convex nervures, but only the two most anterior cubital branches become convex nervures.

The nervures arise by the thickening of narrow membranous folds on each side of the wing over those tracheæ which become converted into nervures. The tracheæ themselves are single, but the cuticular structures which fuse into nervures are double. The closure of the primitively open wing-cells is effected by purely cuticular thickenings. The so-called costa of the hindwing is formed by the fusion of the subcostal with the first radial branch. The author is not inclined to accept the views of Adolph as to the morphology of the nervures of the wings of butterflies.

Effects of different Temperatures on Pupæ of Lepidoptera.†—Mr. F. Merrifield has been making experiments on the conspicuous effects on the markings and colourings of Lepidoptera caused by exposure of the pupæ to different temperature conditions. He finds that both the marking and the colouring of the perfect insect may be materially affected by the temperature to which the pupa is exposed. The markings are chiefly affected by long-continued exposure, probably previous to the time when the insect begins to go through the stages between the central inactive stage and emergence. Colouring is chiefly affected during the penultimate pupal stage, that is, before the colouring of the imago begins to show. A low temperature during this stage causes

* Zool. Anzeig., xiv. (1891) pp. 116–7.

† Trans. Entomol. Soc. Lond., 1891, pp. 155–68 (1 pl.).

darkness, while a high temperature has the opposite effect. In the species operated upon a difference between 80° and 57° is sufficient to produce the extreme variation in darkness caused by temperature. Dryness or moisture during the pupal period had little or no effect on the species used. If Prof. Weismann's theory that most existing Lepidoptera in Europe and North America have come to us from glacial times or climates is correct, icing the pupæ might assist us in tracing their evolution.

Larvæ of British Butterflies and Moths.*— Mr. H. T. Stainton has produced the fourth volume of the late Mr. William Buckler's account of the British Lepidoptera. In this volume part of the night-flying moths (Noctuæ) are described and figured in great wealth of detail.

Mistake of a Butterfly.†—Dr. R. Blanchard reports that one morning at 8·30 he saw a *Sphinx* fly into a deeply shaded room and examine the flowers on the carpet of the floor. Finding no success it tried those on the wall, and returned to the floor. The author was struck with the way in which the visitor avoided the representations of foliage, and he points out that this strange visit shows that the ordinary explanation that crepuscular plants are visited because of their odour is not completely satisfactory.

The Stinging Apparatus in Formica.‡—Dr. O. W. Beyer maintains that the stinging apparatus in *Formica* is a retrogressive modification of that possessed by *Apis*, *Vespa*, *Myrmica*, and other Hymenoptera. He bases his argument on a solid foundation, for he traces the development of the apparatus through eighteen stages in *Apis mellifica*, through fifteen in *Vespa vulgaris*, through eleven in *Myrmica lævinodis*, through eleven in *Formica rufa*. In all four, the essential parts of the apparatus, their arrangement and their relation to the surface of the body, and the succession of developmental stages are the same. From among the interesting facts which Dr. Beyer brings forward to show that the apparatus in question is retrogressive, not progressive, we may cite the correlation between the poison-gland and the sting. In *Apis* the sting is most complicated, the gland is simplest; in *Formica* the sting is reduced, the gland is very large; the other two genera, *Vespa* and *Myrmica*, are precisely intermediate. It seems most plausible that in the ancestors of *Formica* the sting ceased, for some unknown reason, to be very effective; there was the more need for abundant poison, and the gland grew; the muscles of the sting degenerated, those of the poison reservoir and the duct increased in strength.

Structure and Life-history of Encyrtus fuscicollis.§ — M. E. Bugnion describes this minute Chalcidian, which is parasitic within caterpillars, e. g. those of *Hyponomeuta cognatella*. In the abdominal cavity of the caterpillars he found a closed tube, inclosing the embryos and also the nutritive substance on which the larvæ feed. This tube seems to be formed by the ova themselves. The larva has an anus, though this is said to be absent in other entomophagous forms. When

* London, printed for the Ray Society, 8vo, 116 pp., pls. liv.–lxix.
† Bull. Soc. Zool. France, xvi. (1891) pp. 23–4.
‡ Jenaische Zeitschr. Naturwiss, xxv. (1890) pp. 26–112 (2 pls.).
§ Rec. Zool. Suisse, v. (1890) pp. 435–70 (2 pls.).

the store of nutriment is exhausted, the larvæ burst from the membranous tube into the perivisceral cavity of the caterpillar, where they feed on the lymph of their host. The essential organs are spared, and the caterpillar is apparently unaffected, until the parasites are about to undergo their metamorphosis. M. Bugnion begins to describe the anatomy of the larva, but his general results may be reserved until the publication of the complete memoir.

The Blood of Meloe and the Use of Cantharidine.*— M. L. Cuénot finds that the fluid which is exuded from the tibio-tarsal articulations of *Meloe proscarabeus* and similar insects is blood. It contains normal amœboid corpuscles, abundant fibrinogen which forms a clot, a pigment (uranidine) which is oxidized and precipitated when exposed to the air, a dissolved albuminoid (hæmoxanthine) which has a respiratory and nutritive significance, and finally, dissolved cantharidine. The blood is exuded when the insects are provoked or attacked, and is undoubtedly protective, for reptiles and carnivorous insects dislike it intensely. A mole-cricket on which some of the blood of *Meloe* was sprinkled was thereby saved for some days from the appetite of *Carabus*. The effectiveness of this defence compensates for the softness or incompleteness of the elytra in vesicating insects.

Moulting in Rhynchota.†—Dr. L. Dreyfus formerly shared the general opinion that the new bristles of moulting Rhynchota were made inside the old, and that the latter underwent a process of moulting. In his investigation of Phylloxerinæ he finds that the suctorial bristles are entirely thrown off in moulting, and that entirely new structures are drawn out of sacs which lie at the base of the old ones. In these sacs the new bristles are formed from the "retort-like organs."

Hemidiptera Hæckelii.‡ — Prof. N. Léon describes an interesting Ceylonese insect, which he at first mistook for a species of *Halobates*, but soon recognized as Dipterous. There are three simple eyes besides the compound pair; the wings are like those of Diptera; the mouth-parts resemble those of Hemiptera; but so many of the characters are neutral that Prof. Léon proposes to compound the names of the two orders in the generic title *Hemidiptera*, while the specific title records that of the discoverer. He describes the external features, and naturally wishes that he could do more.

Metamorphoses of Oxyethira.§ — Herr F. Klapálek describes the metamorphoses of *Oxyethira costalis* Curt. or *Lagenopsyche* Fr. Müller. The larva is Campodeiform, in form suggesting a queen-Termite. The head and thorax are relatively small; the abdomen is expanded. The mouth-parts and all the external features are described. The nymph is spindle-shaped, broadest about the first abdominal segment; the two sexes are approximately the same in size. Klapálek also describes the "house," how the larvæ close its openings and fasten it to the leaves of water-plants, how the nymphs rest within it, and so on, but the special

* Bull. Soc. Zool. France, xv. (1890) pp. 126–8.
† Zool. Anzeig., xiv. (1891) pp. 61–2.
‡ Jenaische Zeitschr. f. Naturwiss., xxv. (1890) pp. 13–15 (1 pl.).
§ SB. K. Böhm. Gesell. Wiss., ii. (1890) pp. 204–8 (1 pl.).

contribution which his paper makes is the detailed description of the larvæ and nymphs.

Development of Central Nervous System of Blatta germani.*—Mr. N. Cholodkovsky has a preliminary notice of his observations on this subject. The nerve-groove is not continuous at first, but arises gradually by the union of separate small pits, which appear at the base of the developing extremities. It is continued forwards into two tentacular grooves. The supra-œsophageal ganglion arises from three pairs of rudiments, of which the first pair is pre-oral, the second lies on either side of the mouth, while the third is largely post-oral and forms the future optic lobes. The pre-oral and optic rudiments arise by delamination of the ectoderm, and are from the first covered by epithelium, while the adoral rudiments (which the author proposes to call the embryonic tentacular lobes) are for a long time naked. The ventral cords of the nervous system are also for a long time without any covering of epithelium.

After the dotted substance has become differentiated in the ganglionic rudiments the supra-œsophageal ganglion contains three pairs of aggregations of dotted substance corresponding to the three pairs of rudiments of which it is made up. It seems probable that the supra-œsophageal ganglion of all Insects is really made up of three ganglia, and thus, therefore, their head consists of at least six metameres.

Thysanura of Bohemia.†—Herr J. Uzel gives an account of these in a monograph which deals with seventy-six species, and describes twelve new species—two of *Smynthurus*, one of *Orchesella*, two of *Lepidocyrtus*, two of *Entomobrya*, two of *Isotoma*, and three of *Achorutes*.

γ. Prototracheata.

Peripatus Leuckarti.‡—In his additional notes on this interesting form, Mr. J. J. Fletcher calls attention to its existence in the midst of "the bleakness and winter snow of Mount Kosciusko," N.S.W. The prevalent colours of the species are indigo-blue and red, either of which may predominate; the former passes into black in some specimens, and the latter into orange or yellow. There is a median longitudinal dark linear stripe running down the back, in the middle of which is a fine microscopic, sometimes interrupted, line free from dark pigment. It seems no longer doubtful that constant specific characters are not derivable from the pattern and coloration of *P. Leuckarti*. The author adds some useful anatomical details.

δ. Arachnida.

Embryology and Phylogeny of Pycnogonids.§—Mr. T. H. Morgan has made a study of the embryology of *Tanystylum*, *Phoxichilidium*, and *Pallene empusa*. The differences exhibited by the last may be considered as being due to an abbreviation of what is seen in the second of these genera.

The author is of opinion that the Pycnogonids and Arachnids are

* Zool. Anzeig., xiv. (1891) pp. 115–6.
† SB. K. Böhm. Gesell. Wiss., ii. (1890) pp. 1–82 (2 pls.).
‡ Proc. Linn. Soc. N.S.W., v. (1890) pp. 469–86.
§ Studies from Biol. Lab. John Hopkins Univ., v. (1891) pp. 1–76 (8 pls.).

more closely allied than some later systematists have been inclined to allow. The mode of formation of the endoderm by a process of multipolar delamination is only seen in these two groups; the mode of origin of the stomodæum is the same in both, and the early formation of the body-cavity in the legs of Spiders has an exact parallel in *Pallene* and *Phoxichilidium*. In both groups, again, there are well-marked diverticula from the mid-gut into the legs, and in both the first pair of appendages is chelate.

There is a general resemblance between the Nauplius of the Crustacea and the larva of Pycnogonids, but the differences become greater and greater the more closely we examine the two forms; for example, none of the appendages of the Pantopod-larva are biramous, and the first pair is chelate. As to the affinities to the trochophore-larva, the author suggests that the Arachnids may have come from Annelid ancestors with many segments, and that the pantopod represents the most anterior segments of the adult Sea-Spiders, and, therefore, to some extent the anterior segments of Annelids or of the trochophore. But at no time in the ontogeny of the Pycnogonids have the trochophore and pantopod larvæ been transformed the one into the other, as Dohrn believes.

Mr. Morgan next gives a detailed account of the remarkable metamorphoses of *Tanystylum* which can hardly be made intelligible without figures.

In the third section of the paper the structure and development of the eyes of Pycnogonids are considered. All the evidence seems to show that the eye has developed by the turning in of two sides of a primitive optic vesicle, and that the simple eyes of Insects furnish all the intermediate stages, both in development and in adult structure, between a simple cup-like invagination and the three-layered condition of the Pycnogonid eye.

The development of this eye seems to have been abbreviated, and this shortening of the history complicates the matter; the presence of the eye in all the larval stages, in which it was presumably functional, must have changed to a very great extent the original process. Yet in all stages the three-layered condition of the eye may be recognized. The author thinks that in Pycnogonids the invagination (of the Arachnid type) has been retarded, so that, one end of the invagination having been formed, the inturned and inverted cells have functioned as larval eyes, and as the animal increased in size the invagination kept pace, adding more and more cells to the layers of the eye, so that all of the stages had presumably functional eyes, and at the same time the larva retained the original type of Arachnid invagination.

ε. Crustacea.

Bathynectes, a British Genus.*—Canon A. M. Norman reports that *Bathynectes*, a genus formed by Stimpson for certain Crabs nearly related to *Portunus*, is represented by two species in the British area; one, *B. superba*, has only been taken twice from 345 to 400 fathoms, but *B. longipes* appears to be much more common.

* Ann. and Mag. Nat. Hist., vii. (1891) pp. 274–6.

Embryology of Isopoda.*—Dr. J. Nusbaum gives a preliminary account of the results of his studies on the development of some marine Isopods taken at Concarneau.

Germinal Layers and Digestive Tract of Ligia oceanica.—In the earliest stage observed a layer of very finely granular protoplasm was seen at one pole of the egg; this occupied about a third of the periphery of the egg, and the whole of the rest was filled up with nutrient yolk. Only two oval, fine nuclei, which contained a number of chromatin granules, were observed in this protoplasmic layer; they may be regarded as the first products of the segmentation nucleus. In the next stage of development the layer extends itself more or less regularly over the whole periphery of the egg; the nuclei multiply and gradually extend through the layer. These blastoderm-nuclei elongate considerably before division; they appear to move about in amœboid fashion, as they are seen in sections to be provided with pseudopodia; these seem to be the objects which, in *Porcellio scaber*, Reinhard took for cells.

In the next stage of development a special layer of protoplasm becomes differentiated around each blastoderm-nucleus, and in this way a layer of blastoderm-cells is formed which becomes closely packed at that pole which corresponds to the future ventral surface and the hinder part of the embryo; this is the first sign of the germ-stripe. Somewhat later this spot becomes triangular in form and exhibits some signs of differentiation; the rest of the egg is formed of much-flattened cells, which are widely separated from one another; the blastodermal layer is several cells thick at various points, and some of the cells separate off and wander in the yolk.

The epithelium of the mid-gut and of the "hepatic" tubes is formed from two anterior aggregations of endodermal cells, just as in *Oniscus*. The salivary glands are evaginations of the stomodæum, and not of endodermal origin, as the author thought when describing *Oniscus*. It is important to note that the mesoderm arises from paired rudiments, as is the typical case in other Enterocœlia.

The Germ-stripe and the Extremities.—The author recognizes a stage corresponding to that of the Nauplius, and in the germ-stripes of this stage there are paired optic lobes and paired rudiments of the endoderm. The cells of that part of the germ-stripe that lies behind the third pair of extremities are regularly and segmentally arranged; at the hindermost, somewhat thickened and broader end there are some rows of closely packed and very regular larger cells, from which new segments are given off anteriorly. This segment-forming zone lies in front of what will be the anus; this last corresponds to the hinder part of the blastopore.

At a later stage there may be observed two optic lobes, two pairs of antennæ, a pair of mandibles, two pairs of maxillæ, and a pair of maxillipeds. The last and antepenultimate have two branches, while all the extremities of the mid- and hind-body are two-branched. In those of the mid-body the outer branch disappears later on. The cephalic nervous system is formed from two pairs of ectodermal thickenings which lie internally to the antennæ, while internally to all the other appendages are the rudiments of the ganglia of the ventral chain. Externally to all but the four foremost pairs of appendages there are

* Biol. Centralbl., xi. (1891) pp. 42 9.

paired thickenings of the ectoderm which occupy the same position as the stigmatic orifices in the germ-stripes of the Tracheata, and which are the rudiments of the lateral folds which serve to form the parts that correspond to the pleura.

Formation of Eggs in Testis of Gebia major.*—Dr. C. Ishikawa describes the hinder part of the testis of this Crustacean as having, to the naked eye, an undoubted resemblance to an ovary. In the anterior part or testis proper there extends, along its whole length, a germinal band in which young spermatic cells are to be found; the ripe spermatozoa are of nearly the same shape as those of *Gebia littoralis* described by Grobben.

In the hinder part of the organ there is still the germinal band, but its cells are differentiated into egg-cells of large size. At one point male and female cells lie among each other.

This condition of things obtained in all the twenty males examined; all the males are well characterized by secondary sexual characters, so that we have a new case of male animals producing in part the female elements. Here, as in the similar case of *Orchestia*, the eggs do not pass out of the generative organ; the author thinks that the eggs atrophy at certain seasons of the year.

Mediterranean and Atlantic Halocyprides.†—Prof. C. Claus gives an account of the genera and species of this group of Ostracoda, with notes on their organization. The chief anatomical characters of the family are the absence of the paired lateral and the trifid median eyes; the heart is short and saccular, with a hinder dorsal pair of clefts and an anterior arterial ostium, and lies above the stomach. At the commencement of the stomach there are two short, saccular, hepato-pancreatic tubes, which do not pass between the shell-fold. There is no anus, in consequence of the degeneration of the hind-gut. The paired gonads lie symmetrically and dorsally by the sides of the stomach. The male has a copulatory organ on the left side which is formed by the union of two metamorphosed appendages of that side. The copulatory orifice and the receptaculum seminis lie on the right side of the body of the female, and the egg-pouch on the left. The ova appear to be deposited separately.

The young, on emergence, appear to have their full complement of limbs, and only differ from sexually mature animals by the smaller size of the body and its extremities, and some unimportant points, such as the smaller number of furcal hooks; in some points the young male has the characters of the female.

The first subfamily is that of Conchœcinæ, in which are included *Conchœcia* Dana (*C. subarcuata*, *bispinosa*, *hyalophyllum*, *porrecta*, and *striata* spp. nn.); *Paraconchœcia* g. n. for *P. oblonga*, *spinifera*, *inermis*, and *gracilis* spp. nn.; *Conchœcetta* g. n. for *C. acuminata* sp. n.; *Conchœcilla* g. n. for *C. daphnoides* sp. n.; *Conchœcissa* for *C. armata* sp. n.; *Pseudoconchœcia* for *Conchœcia serrulata* Claus; *Mikroconchœcia* for *Halocypris Clausi* Sars. The second subfamily is that of the Halocyprinæ for *Halocypris* Dana (*H. pelagica* and *distincta* spp. nn.) and *Halocypria* Claus.

* Zool. Anzeig., xiv. (1891) pp. 70-2.

† Arbeit. Zool. Inst. Wien, ix. (1890) pp. 1-34.

Some notes are next given on the nervous system and sensory organs, the enteric canal and glands, the circulatory and respiratory organs, and those of reproduction.

The fact that the copulatory apparatus is formed from two rudimentary appendages of the left side shows that the Phyllopod-like stem-forms of the Ostracoda had a larger number of limbs, and that the number —seven—found in Ostracods is a reduction. It remains doubtful whether the same appendages have been retained in the various families.

Nervous System of Diaptomus.*—M. J. Richard has studied the nervous system of several species of this genus of Copepods, and finds them to agree in the characters now to be mentioned. The system is composed of a large supra-œsophageal ganglion united by two connectives with a subœsophageal ganglionic mass which is continuous with a ventral chain which is prolonged as far as the point of insertion of the fourth pair of limbs. The brain is an irregular mass formed of a central nucleus of dotted substance invested in a layer of cellular elements; this layer varies in thickness at different points. A primary may be distinguished from a secondary brain; the former consists largely of dotted substance, the latter is almost exclusively formed of nerve-cells. The nerves given off from the brain are those for the frontal organ, three for the eyes, two for the first pair of antennæ, and an azygos ventral branch which passes to the labrum.

The connectives of the œsophageal collar are very strong at their point of origin, and have nerve-cells scattered more or less over the whole of their outer side, but none on the inner: nerves are given off to the second pair of antennæ; a little lower a large nerve passes into the labrum; below, the two connectives are united by a transverse commissure.

The subœsophageal mass is formed of several ganglia and has the form of a band, wide anteriorly, which diminishes slightly in width at the level of the first maxillipede. There are three cellular swellings whence nerves are given off to the mandibles, maxillæ, and maxillipedes.

Between the first and second thoracic ganglia the ventral chain is reduced to a feeble cord, oval in section anteriorly and almost circular further back. These thoracic ganglia do not agree in the relations which they bear to the corresponding appendages. At the level of the fourth pair of limbs the ventral chain bifurcates at a ganglionic centre, whence nerve-trunks are prolonged into the abdomen, and which corresponds to a fifth ganglion. A rather large number of nerves is given off from the course of this ventral ganglionic chain.

Various parts of the nervous system exhibit regular lacunæ, which are continued through a long series of sections and are seen to form true canals which are, no doubt, destined to serve for the nutrition of the nerve-chain. The parts are enveloped in an extremely delicate neurilemma which is, at points, difficult to see. The author adds that he has never come across the "classical" nerve-cell with its abundant protoplasm; all the cells were of the ordinary unipolar type.

A condition of things very similar to that of *Diaptomus* is to be found in *Heterocope saliens*.

* Bull. Soc. Zool. France, xv. (1891) pp. 212-8.

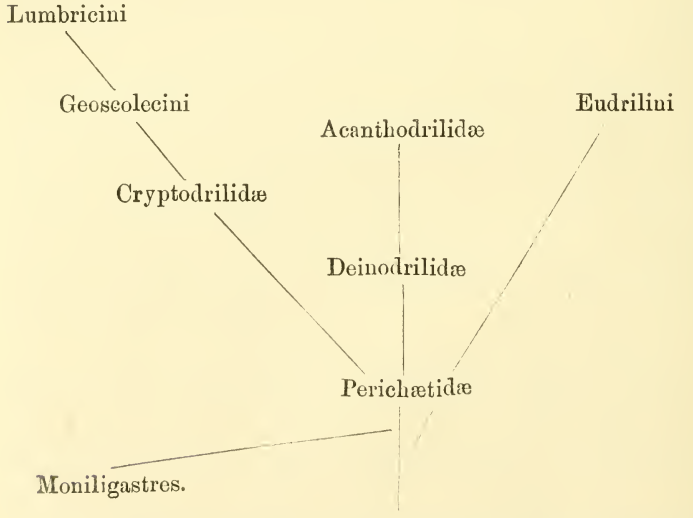
Males of Freshwater Ostracoda.*—M. R. Moniez states that, in collections brought from various parts of the world, he has not found the males of *Cypris* or of *Herpetocypris* to be rare as naturalists acquainted only with the European representatives of these genera would have supposed. He cannot find that the time of the year, climate, or salinity of the water are factors in producing males.

Vermes.

a. Annelida.

Classification and Distribution of Earthworms.†—Mr. F. E. Beddard commences his essay with a historical recapitulation of what has been done for the classification of earthworms by Perrier, Vejdovsky, Rosa, and others; the work of Rosa is critically considered, and the suggestion is made that the key to the classification of the group is to be found in the modifications of the excretory system. He associates those earthworms which have a nephridial system built upon the Platyhelminth type into one group, which is termed that of the Acanthodrilini, and which is divisible into the Perichætidæ, Cryptodrilidæ, Deinodrilidæ, and Acanthodrilidæ. The unique characters of the reproductive efferent apparatus requires the formation of a separate group for the Eudrilini. The family Lumbricidæ form the third group of Lumbricini. A combination of characters distinguishes the group Geoscolecini which contains the families Urochætidæ, Geoscolecidæ, and Rhinodrilidæ.

The relationships of the various divisions of earthworms may be indicated by the following table:—



The chief facts brought out by an examination of the distribution are, the author tells us—(1) The close resemblance between the Palæarctic

* Comptes Rendus, cxii. (1891) 669–72.

† Proc. Roy. Phys. Soc. Edinb., 1889–90 (1891) pp. 235–90 (2 maps).

and Nearctic regions, which necessitates their fusion into a Holarctic region; (2) the separation of Japan from the Palæarctic and its relegation to the Oriental region; (3) the great richness of South America and Australia in peculiar types; (4) the wide distribution of *Acanthodrilus* in the land masses of the southern hemisphere, which agree in the great abundance of species of this genus and comparative rarity of other forms; and (5) the marked difference between New Zealand and Australia.

Structure of New Earthworms.*—Mr. F. E. Beddard gives an account of the structure of two new genera of Earthworms belonging to the Eudrilidæ and coming from Lagos, West Africa. These new genera he calls *Heliodrilus* and *Hyperiodrilus*. As in other Eudrilidæ, and them only, the epidermis is furnished with peculiar organs which may be sensory; they have some resemblance to the Pacinian bodies of Vertebrates, and are scattered irregularly over the surface of all the segments except the first. There is only one pair of calciferous glands; in each of the tenth, eleventh, and twelfth segments there is a median diverticulum of the œsophagus; the epithelium of this is so folded as to present the appearance of a series of parallel tubes; the peripheral cells are excavated and form a ramifying system of ductules. There is no anterior gizzard, but there are six segmentally arranged gizzards at the junction of the œsophagus and intestine.

The supra-intestinal blood-vessel in the œsophageal region is inclosed in a special cœlomic compartment, which is almost filled by nucleated corpuscles. The male genital pore is single and median on segment xvii.; the "atria" are glandular and very long; there are no penial setæ, but in *Hyperiodrilus* there is a penis in the form of a hollow process of the body-wall. The ovaries are inclosed in special cœlomic sacs which communicate with the egg-sac, and are prolonged dorsally so as to entirely or partially inclose the single spermatheca which opens on the middle line. In *Hyperiodrilus* the perigonidial sacs form a ring round the œsophagus, and are connected with a dorsal unpaired sac.

Mr. Beddard has been able to examine some specimens of *Nemertodrilus* which may be referred to the Eudrilidæ for several reasons; the absence of certain characters ordinarily seen in Eudrilids is perhaps a sign of degeneration.

Structure of Deodrilus and Anal Nephridia in Acanthodrilus.†—Mr. F. E. Beddard describes an Oligochæte from Ceylon, which, on account of its intermediate characters, he calls *Deodrilus*; the species is *D. Jacksoni*. It is most closely allied to the Geoscolecidæ and Eudrilidæ as lately defined by Rosa. Like some of the former it has no prostomium; in the characters of its clitellum, &c., it is intermediate; the possession of ornamented setæ shows its affinity to *Rhinodrilus*; in the presence of a diffuse nephridial system it resembles certain genera of the Eudrilidæ. Concise definitions of the genus and species are given.

In a specimen of, apparently, *Acanthodrilus multiporus* tubes of precisely the structure of nephridia and communicating with the general system may be followed, through the lining epithelium of the

* Quart. Journ. Micr. Sci., xxxii. (1891) pp. 235-73 (5 pls.).
† Op. cit., xxxi. (1890) pp. 467-88 (2 pls.).

gut, into the lumen, into which they open. As there are anal nephridia in the Gephyrea and as many Arthropods are provided with gut-tubes—the Malpighian tubules—this discovery is of interest, and may prove to throw light on the origin of these last, which have, indeed, been already compared to nephridia.

Aquatic Earthworms.*—Mr. F. E. Beddard remarks that *Allurus tetraedrus* is not the only "earthworm" that has been found in water. Two freshwater species of *Acanthodrilus* have been found in the Falkland Islands.

Perichæta indica.†—Mr. R. Service has a note on the occurrence of this exotic species in hot-houses; he thinks an extensive search would show that it is of general distribution in British hot-houses kept at a high temperature.

Development of Vascular System in Annelids.‡—Dr. F. Vejdovsky discusses this subject with special reference to embryos of *Allolobophora fœtida*, *All. putra*, *All. trapezoides*, and *Rhynchelmis*, of which figures are given. The whole paper is, unfortunately, in Bohemian.

Phymosoma.§—Mr. A. E. Shipley, while describing a new species of *Phymosoma*, takes the opportunity of giving a synopsis of the genus and some account of its geographical distribution. *P. Weldoni* sp. n. is from Bimini Island, the Bahamas; the tentacles, of which there are from seventy to ninety, are distinguished from those of *P. varians* by the absence of the rows of skeletal cells which form so interesting a feature of the latter species. Their place is occupied by a well-developed fibrous connective tissue, which passes down into the base of the lophophore and is there continuous with the connective tissue which surrounds the œsophagus, and which serves as a point of attachment to the retractor muscles. The absence of hooks on the introvert is a marked feature of this new species. The blood-reservoir is much larger and the heart longer than in *P. varians*, and the latter organ becomes involved in the twisting of the alimentary canal, while its capacity is much increased by a number of small diverticula, which project as finger-like processes. The blood-corpuscles are either large clear cells with well-developed outlines, a well-stained nucleus and, apparently, no cell-contents, or smaller bodies with a protoplasmic body which stains well and a central nucleus.

The genus is divided into species that (I.) are without and (II.) have hooks; of the former four have four retractors and one (*P. Weldoni*) two; of the latter one has two, one three, and the rest (19) four retractors.

With regard to their geographical distribution, the existing body of evidence points to the Malay Archipelago as the head-quarters of the genus; with but few exceptions, it is only found in tropical seas, and the species have a preference for shallow waters. These latter facts may be explained by the fact that the animals only flourish in comparatively warm water. These conditions of temperature may be the

* Quart. Journ. Micr. Sci., xxxi. (1890) pp. 208–10. † T. c., pp. 390–8.
‡ SB. K. Böhm. Gesell. Wiss., ii. (1890) pp. 155–64 (1 pl.).
§ Quart. Journ. Micr. Sci., xxxii. (1891) pp. 111–26 (1 pl.).

cause of the association of specimens of *Phymosoma* with coral islands, but it is to be observed that several species make their homes in tubular holes burrowed in the soft coral rock.

β. Nemathelminthes.

Gordius tolosanus and Mermis.*—Dr. v. Linstow corroborates his discovery that the beetle *Pterostichus niger* is the host of the larval *Gordius tolosanus* Duj. As the pools in which the Nematodes are found dry up in summer, it seems that the beetles must repopulate them each spring. In the spring months the beetles fall into the pools and are drowned; from their bodies the nematodes pass into the water. Trout and some other fishes occasionally contain these parasites, which is readily explicable on the supposition that the fishes have devoured infected beetles. Meissner observed the larvæ of *Gordius tolosanus* boring into Ephemerid larvæ; it is perhaps in the Ephemerids that the parasites leave the pools and are eaten by beetles. The life of this nematode is annual. The sexual union, which Meissner observed, may take place in April; the females deposit the eggs in snow-white strings on the stems of water-plants; the development is completed in about four weeks. The structure of the larva is described, and von Linstow adds some details to his previous account of the adults. He also reports his discovery of the larvæ of *Mermis crassa* in the aquatic larvæ of *Chironomus plumosus*. In *Hyalina cellaria*, the larva of *Mermis Hyalinæ* was found, a fact of interest since only two other instances of Molluscs as hosts of *Mermis* are on record.

Arabian Nematodes.†—Mr. N. A. Cobb has collected more than two hundred marine Nematodes from the coast of Arabia, among which seven distinct species have been recognized; all may be referred to genera known to inhabit Atlantic waters. The author proposes a system of formulæ which reads thus for a species of *Oncholaimus*:—

$$\frac{1\cdot\ \ 8\cdot2\cdot\ 17\cdot2\cdot\ 52\cdot\ 93\cdot3}{\cdot9\ 1\cdot5\ \ \ 1\cdot6\cdot\ \ 1\cdot7\ \ \cdot8}\,1\cdot77 \qquad \frac{\cdot8\ \ 8\cdot\ 16\cdot6\ \mathrm{M}\ 94\cdot1}{\cdot8\ \ 1\cdot3\ 1\cdot4\ 14\ \ \ \cdot8}\,1\cdot85$$

These numbers refer respectively to the pharynx, nerve-ring, base of neck, vulva, and anus; M stands for male; the numbers above the horizontal line relate to longitudinal and those below it to diametral measurements. Reading the formula from left to right reads off the dimensions of the animal from head to tail. The peculiarity of the formula is that the unit of measurement is not absolute but relative, being nothing else than the hundredth part of the length of the worm itself. The absolute length of the animal expressed in millimetres is put to the right. Mr. Cobb urges various recommendations for this formula, and expresses a belief that by averaging the specific we may get a generic formula. The seven new species found are fully described.

Echinorhynchus polymorphus and filicollis.‡—Prof. M. Braun gives reasons for thinking that *E. filicollis* Rud. is not, as is now generally

* Arch. f. Mikr. Anat., xxxvii. (1891) pp. 239-49 (1 pl.).
† Proc. Linn. Soc. N.S.W., v. (1890) pp. 449-68.
‡ Centralbl. f. Bakteriol. u. Parasitenk., ix. (1891) pp. 375-80.

supposed, a synonym of *E. polymorphus* Brems. Externally they may be distinguished by the smaller size of the latter, and its constant orange-red colour, while the female of *E. filicollis* is yellowish-white and the male whitish. There are also important internal differences.

γ. Platyhelminthes.

Connecting Canal between Oviduct and Intestine in Monogenetic Trematodes.*—Mr. S. Gote is able to confirm the statement of Ijima that a peculiar canal connects the oviduct with the intestine in some ectoparasitic Trematodes. The canal which Zeller calls Laurer's canal in *Diplozoon* is evidently this structure; the vas deferens of one individual of this twin-form distinctly opens into the yolk-duct of the other.

The Holostomidæ.†—Dr. G. Brandes gives a monographic account of this family of Trematodes, the known species of which are not very numerous. They are all characterized by the presence, below the ventral sucker, of a structure which divides the body into an anterior and a posterior region. The simplest form is that of a lamella; in some the anterior end becomes spoon-shaped, and this passes through various stages of complication to that of a cup. The anterior and posterior halves of the body are very rarely set in the same plane.

With regard to the food of these internal worms there is reason to suppose that they are not simply contented with what falls from the plate of their host, but that they are aggressively parasitic; they are not confined to the small intestine, but are also found in the rectum and bursa Fabricii, where the supply of food is not so abundant. The possession by them of holding organs supports this view. In, for example, *Hemistomum cordatum*, a parasite of the wild cat of Brazil, the ventral sucker is greatly reduced, but an attaching apparatus is enormously developed, and has connected with it a complex of glands. This attaching organ may be formed on one of two types, both of which are described in detail. The digestive organs are also described.

The male and female organs are united in the same individual, and the whole generative apparatus is characterized by the position of the efferent ducts at the hinder end of the body, while the uterus is only slightly coiled.

Less constant characters are the position of the ovary between the two testes, and the separate course of the duct of Laurer. The whole generative apparatus is always placed in the hinder part of the body. Here, again, full details are given. Some additions are made to our knowledge of the water-vascular system.

No previous author seems to have reported on the nervous system of these worms. In young stages of *Hemistomum* Dr. Brandes has, after treatment with osmic acid, seen the central mass of the nervous system lying on the lower part of the pharynx. Inferiorly two strong processes could be traced for some distance, while superiorly there branched off a pair of very short and delicate processes. In sections nervous elements have been observed in the parenchyma of the anterior end of the body.

* Zool. Anzeig., xiv. (1891) pp. 103–4.

† Zool. Jahrb. (Abth. f. Systematik &c.), v. (1890) pp. 549–604 (3 pls.).

Little is as yet known as to the details of the developmental history of these worms.

In the second or systematic portion of his work, the author, after some preliminary observations, defines the family Holostomidæ, which he divides into (1) the Diplostomeæ, with much flattened fore-bodies, and containing *Diplostomum* (with four new species) and *Polycotyle;* (2) the Hemistomeæ, in which the sides of the fore-body are curved round, and containing *Hemistomum* (with fourteen species, one of which is new); (3) the Holostomeæ, in which the fusion of the lateral edges of the flattened fore-body has led to the formation of a cup; in this are included the twenty-eight known species of the genus *Holostomum*, some of which are now for the first time described.

Anomaly of Genital Organs of Tænia saginata.*—Dr. R. Blanchard calls attention to a curious inversion of the genital organs of this Cestode. A segment about the 750th, situated between two normal joints which contained a large number of testicular vesicles but in which the uterus had already numerous lateral ramifications, was found to be larger than its neighbours; there was some trace of an aborted intercalated ring; on either side was a marginal pore. Of these, that on the right side was related to a complete hermaphrodite apparatus, which presented all the usual characters; the apparatus, however, which was connected with the left pore had a normal unpaired ovarian lobe, two feebly developed lateral lobes, and a normal body of Mehlis. With this latter was connected a vagina which was curved from behind forwards and was accompanied by an efferent canal of normal aspect.

δ. Incertæ Sedis.

Bohemian Rotifera.†—Herr F. Petr gives a list of Rotifera from Bohemian highlands. He enumerates eighty species including two new forms, *Floscularia diadema* and *Rattulus antilopæus*.

Galician Rotifers.‡—Dr A. Wierzejski gives a list of fifty species of Rotifera found in Galicia. *Brachionus forficula* is a new species, and varieties of *Polyarthra platyptera*, *Schizocerca diversicornis*, and *Brachionus dorcas* are described.

Echinodermata.

Echinoderms of Ceylon.§—Prof. H. Ludwig reports on a small collection of Echinoderms from Ceylon, six of which are now recorded for the first time from the shores of that island. The most interesting of the observations are, however, on an already recorded species *Ophiomastix annulosa*. The dorsal knob-like spines were found to differ in minute structure from the ordinary arm-spines, for their epidermis was very much thicker and was very richly supplied with nerves. On this point Hamann has already made some observations and has suggested that some of the cells are sensory. Prof. Ludwig would rather regard these as supporters to the glandular cells, but it is obvious that the question is not one that can be settled on spirit specimens.

* Bull. Zool. Soc. France, xv. (1890) pp. 166–8.
† SB. K. Böhm. Gesell. Wiss., ii. (1890) pp. 215-25 (2 figs.).
‡ Bull. Soc Zool. France, xvi. (1891) pp. 49–52 (4 figs.).
§ SB. Naturhist. Ver. Preuss. Rheinland, xlvii. (1890) pp. 98–105

Perisomatic Plates of Crinoids.* — Messrs. C. Wachsmuth and F. Springer consider that the plates of a Crinoid fall naturally into two categories, the primary and secondary or supplementary plates. The primary form the fundamental part of a Crinoid, while the supplementary pieces serve to fill up spaces. The former may be separated into two classes: those developed on the right antimere, which, in one way or another, are related to the axial nerve-cords, and those developed on the left antimere and connected with the mouth or the annular vessel around it. To the first class they refer the stem-joints, basals, underbasals, radials, all brachials, whether fixed or free, and the plates of the pinnules; to the second the orals and all plates of the ambulacra to the end of the pinnules. The remaining plates are supplementary, and, in the opinion of the authors, neither strictly actinal nor abactinal.

Messrs. Wachsmuth and Springer would apply to all plates interradially disposed in the calyx the term interradials, and use interbrachials as a general term for all plates between the rays above the radials; the terms "interdistichals," "interpalme[a]rs," and "interambulacrals" explain themselves. They conclude with a criticism of some of the recent work of Mr. F. A. Bather.

Ovary of Ophiurids.†—Sig. A. Russo has studied the disruption and renewal of the ovarian parenchyma in *Ophiothrix fragilis*, *Ophioderma longicauda*, and *Ophiomixa pentagona*. The germinal vesicle and spot become hyaline or colloid, or, rarely, undergo fatty degeneration and chromatolysis. The vitellus and vitelline membrane also degenerate. Meanwhile, however, there is a process of regeneration, in which fresh elements are formed from follicular cells.

Revised List of British Echinoidea.‡—Mr. W. E. Hoyle has prepared a list of British Echinoids, giving some synonymy, brief definitions of genera and species, and the distribution in British seas and elsewhere. Twenty-nine species are recognized as British; Forbes, it will be remembered, enumerated only twelve. The general classification followed is that of Prof. Duncan.

Anatomy of Synaptidæ.§—Prof. H. Ludwig and Herr P. Bartels have investigated the anatomy of these Holothurians. They find that adult Synaptids have no radial water-canals. In all cases they found the radial nerve accompanied by an epineural space above, and below by a pseudhæmal space, but there were no signs of any water-vessel. As they are found in the young this reduction helps to support the view that the Synaptidæ cannot in any way be considered as primitive forms of the Holothurioidea. The semilunar valves of the tentacular canals were found, under similar conditions, in all the forms examined. Auditory vesicles were also always present; a pair is found on each radial nerve, at the point where the nerve emerges from the radial piece of the calcareous ring; they are either supplied by a short branch of the radial nerve, or they are placed directly on it. The so-called eyes of *Synapta vittata* are undoubtedly sensory organs; each pigment-spot has an en-

* Proc. Acad. Nat. Sci. Philadelphia, 1890, pp. 345–92 (2 pls.).
† Zool. Anzeig., xiv. (1891) pp. 50–9 (15 figs.).
‡ Proc. Roy. Phys. Soc. Edinb., 1889–90 (1891) pp. 398–436.
§ Zool. Anzeig., xiv. (1891) pp. 117–9.

largement of the tentacular nerve, which is distinguished by the presence of a large group of transparent sensory cells, surrounded by pigment; the whole group is invested by a pigmented layer. In *S. orsinii* each tentacular nerve gives off a short nerve-branch, the end of which enlarges into a spherical ganglionic structure. It may be supposed that the paired pigment-spots known to exist in *S. lappa* and *S. vivipara* are sensory organs. The fibrous bundles which are inserted into the inner side of the wheels of species of *Chiridota* arise from a mass of connective tissue common to the whole wheel-papilla, and consist of six fibres of equal thickness.

Fission of Cucumaria planci.*— Mr. H. C. Chadwick observed an adult *Cucumaria planci* become motionless and so remain for two days; it then became much attenuated in its middle, and the rupture which ensued and slowly elongated brought the intestine into view. The two ends snapped asunder, and the anterior slowly crawled onwards. The projecting intestine eventually decomposed. A fortnight afterwards the posterior half had a new mouth and a circlet of minute tentacles. In six weeks the author's three specimens were increased to seven, and a large number of ova had also been deposited.

Cœlenterata.

Organization and Development of Anthozoa.†—M. P. Cerfontaine has a preliminary notice of the results of his studies on various Anthozoa. He has studied the development of the twelve first septa in *Cereactis aurantiaca;* he finds that the laws of their appearance are identical with those recently formulated for *Manicina areolata* by Wilson. In young larvæ there is only one pair of septa, which divide the cavity into two unequal chambers; the second pair soon appears in the larger chamber, and the third in the smaller. The fourth, contrary to the statement of Lacaze-Duthiers, appear in the space bounded by the septa of the second formation, and not between the first and second septa.

The development of the sarcosepta of *Asteroides calycularis* has been investigated. After the first twelve sarcosepts have become united by their inner edge to the œsophagus, four new pairs, and then two others appear; they become of the same size as the first six pairs, and also become united with the œsophagus. Finally, twelve new pairs are developed between the first twelve, and bring the number of sarcosepts up to forty-eight; these last attain a full development, but do not unite with the œsophagus. The author was enabled to completely follow the course of development of the tentacles in *A. calycularis*, and he finds the order of the appearance as described by Lacaze-Duthiers for *Actinia mesembryanthemum.*

Cerianthus oligopodus is a new species from the Mediterranean, distinguished by the smaller number (19) of marginal tentacles from any one of the three species already recorded from that sea.

Alcyonacea of Bay of Naples.‡—Dr. G. v. Koch gives an account of the Alcyonacea of the Bay of Naples. He arranges them in three

* Trans. Liverpool Biol. Soc., v. (1891) pp. 81–2 (1 pl.).
† Bull. Acad. Roy. de Belgique, lxi. (1891) pp. 25–39 (2 pls.).
‡ Mittheil. Zool. Stat. Neapel, ix. (1891) pp. 652–76 (1 pl. and 28 figs.).

families: the Cornulari[i]dæ, in which the polyps are connected with one another by stolons or stolon-plates, and are all of much the same length when fully developed; in the other families—the Alcyoni[i]dæ and the Scleraxonidæ, the polyps are connected with one another by branched tubes, which rise to various heights, and have their walls fused into a common mass. The polyps may be very unequal in length. In the Alcyoniidæ the spicules are separated from one another, while in the Scleraxonidæ they are united into continuous skeletons, either by horny substance or by crystalline calcareous excretions.

Cornularia, *Clavularia*, and *Rhizomenia* are the recognized genera of the Cornulariidæ; *Alcyonium*, *Daniela*, *Cercopsis*, and *Paralcyonium*, of the Alcyoniidæ, and *Corallium* of the Scleraxonidæ.

Clavularia Marioni is a new species; *Daniela Koreni*, new genus and species, and *Cercopsis Studeri* is a new species.

Fissiparity in Alcyonaria.*—Prof. T. Studer calls attention to an Alcyonarian allied to *Gersemia*, and collected by the Prince of Monaco, which shows that fission does occasionally occur among the Alcyonaria. The specimen, unfortunately, is unique, and the author has had to content himself with a superficial examination.

Development of Arachnactis and Morphology of Cerianthidæ.†—Prof. E. van Beneden reminds us that Kowalevsky has shown that the endoderm of *Cerianthus* is formed by invagination, and that this Anthozoon passes through the gastrula-stage. The pharyngeal tube is formed by the pressing back of that part of the wall of the body which immediately surrounds the wall of the gastrula. This is effected in such a way that two endodermic cæca are formed, one on either side of the pharyngeal tube. This latter is flattened and has two surfaces and two edges; the former correspond to the cæca, while the edges are united to the wall of the body. Each cæcum soon divides, by the formation of a partition which unites the wall of the body to the lateral surface of the pharynx, into two chambers. At this time the first two pairs of tentacles have appeared, and they correspond to the first four mesenteric chambers. These results cannot be reconciled with those of Boveri, who makes no mention of Kowalevsky's results; in this Prof. van Beneden thinks he has erred, as his own studies of *Arachnactis* will show. The present observations made on *Arachnactis albida* demonstrate that, at the stage of development which is characterized by the presence of two pairs of tentacles, there are no signs of median chambers; the larvæ have, at the level of the pharynx, two cavities divided into four symmetrical mesenteric chambers. The appearance of these cavities is probably the consequence of the mode of formation of the pharynx and the primitive form of this organ. The pharynx forms a complete partition which separates the right from the left cavity. In the Hexactinaria and Hexacoralla it is different—in them the pharynx from the first occupies the axis of the ovoid larva; their pharynx does not divide the cœlenteric cavity into two lateral parts, and that cavity is undivided.

The first pair of mesenteric septa are transverse in *Arachnactis*, and to the mesenteric cavities there correspond the first two pairs of marginal

* Bull. Soc. Zool. France, xvi. (1891) pp. 28–30.

† Bull. Acad. Roy. de Belgique, lxi. (1891) pp. 179–214 (4 pls.).

tentacles. The antero-median and postero-median chambers become hollowed out in cellular buds which depend from the endoderm. The posterior chamber and the septa which bound it are only just anterior in development to the directive chamber and septa. The succeeding septa are formed in pairs and in the form of folds of the endoderm, in the postero-median chamber. These folds first arise on the neural surface. The two septa of a pair do not arise simultaneously, but successively, the left one being always in advance.

Each new pair of septa arises behind that just formed, with the exception of the directive septa which appear a short time after the septa of the second pair. No trace of longitudinal muscular fibres can be found in the directive or the other septa. On the other hand, a layer of ectodermal muscular fibrils appears early in the wall of the body. It follows from this account and the description of Kowalevsky, that the larvæ of Boveri are not the larvæ of a Cerianthid; the conclusions to which he has come as to the phylogeny of the group depend, therefore, upon an error of interpretation.

The development of Cerianthids differs *ab initio* from that of the Hexactinaria, though certain resemblances are to be seen between them; we cannot suppose that the Cerianthidæ, in the course of their development, pass through an *Edwardsia*-stage. *Edwardsia* has muscles in the septa which are wanting in *Arachnactis*.

Protozoa.

Notes on Ciliated Infusorians.*—M. Fabre-Domergue gives an account of *Lagynus lævis* Quenn. It is extremely flexible and contractile, bending before obstacles and contracting suddenly at the least cause for alarm. It varies extremely in form, and the colour varies with the degree of repletion or emptiness of the individual. It often feeds on prey of enormous size, which it swallows after dilating its buccal orifice to a considerable size. It multiplies abundantly by division in a cyst; this cyst is rounded and has a fine, structureless, and colourless envelope; the contents are granular and opaque in consequence of the presence in the endoplasm of a large number of refractive granules.

Frontonia marina sp. n. was found among putrefying Algæ at Concarneau. The trichocysts of living specimens appear like small, dark, highly refractive dots when seen from in front; from the side they look like rods slightly swollen in their middle, and set almost perpendicularly to the surface of the endoderm. When treated with ammonia, after fixation with osmic acid, they increase considerably in all directions, and lose their characteristic refrangibility. When protruded the trichocysts form long filaments like those of *Paramæcium aurelia*.

Fabrea salina.†—Under this name M. L. Henneguy describes a new Heterotrichous infusorian found at Croisic. It is from 0·45 mm. to 0·13 mm. long, with a pyriform body, the anterior end of which is deeply excavated and carries the peristome. It is violet or greenish black in colour. The peristome is elongated and directed from left to right. It is remarkable for a well-defined pigment-spot which is found

* Ann. de Microgr., iii. (1891) pp. 209–19 (1 pl.).
† Op. cit., 1890, pp. 118–35 (1 pl.).

in the region of the rostrum. The cilia are numerous and long in all parts of the body. There is a terminal anus, and no contractile vacuole. This new generic type has affinities with *Stentor*, *Bursaria*, and *Climacostomum*, and may be placed near this last among the Stentorinæ.

New Pelagic Zoothamnium.*—Dr. G. du Plessis calls attention to a pelagic species of *Zoothamnium*, fine colonies of which are to be found off Villefranche. They never become, even temporarily, fixed. Like other pelagic forms they are absolutely transparent, swim incessantly, and die rapidly in captivity. They are in the form of a star with from four to twelve rays; each ray is a miniature tree, and the branches of the second and third order carry elegant Vorticellids on very long stalks. Along the free edge there are immense cilia which are as long as the whole body. This peristome describes several spiral turns, and near the mouth there is a strong membranella.

A few forms are sessile; these are larger and their peristomial cilia are shorter than in the rest; these are the macrogametes which are characteristic of the genus *Zoothamnium*.

Contraction and extension are very sudden, and it is because of these movements that these transparent creatures are detected. They are best killed by a drop of glacial acetic acid, added at the moment of extension. They may be coloured by methyl-green and mounted in glycerin. In specimens so prepared the ribbon-shaped nucleus may be detected. Dr. du Plessis proposes to call this new species *Z. pelagicum*.

Estuarine Foraminifera of Port Adelaide River.†—Mr. W. Howchin reports the presence in this area of fifty-one species, belonging to fifteen genera. The fauna, as a whole, is characteristic of shallow water and a temperate climate. Two-thirds of the forms are living in British waters, while nearly all the rest are Australian or sub-tropical species. The most interesting are the nine arenaceous species. The rare *Trochammina inflata* occurs in considerable numbers high up the stream; the still rarer *Haplophragmium cassis*, previously known only from a few points on the borders of the Arctic circle, is not uncommon in some portions of the river. *Rheophax nodulosa* is also a characteristic cold water species, living at abyssal depths, where the temperature is low, and reaching its greatest development in size in Arctic and Antarctic waters. *R. findens* is a very rare species, hitherto known from two localities only, one of which is the Gulf of St. Lawrence.

New Sporozoa ‡—M. P. Thélohan describes two new sporozoa, from the muscles of *Cottus scorpio* and *Callionymus lyra*. They resemble the parasite which Gluge described in the skin of the stickleback, a form which M. Thélohan proposes to call *Glugea microspora* g. et sp. n., and also that which Henneguy found in *Gobius albus* and in *Palæmon rectirostris*.

Sarcosporidia.§—Sig. A. Garbini has found in the muscles of *Palæmonetes varians* a Sarcosporid closely resembling but not identical with the form which Henneguy discovered in *Palæmon rectirostris*. Instead of

* Zool. Anzeig., xiv. (1891) pp. 81–3.
† Trans. Roy. Soc. South Australia, xiii. (1890) pp. 161–9.
‡ Comptes Rendus, cxii. (1891) pp. 168–71.
§ Atti R. Accad. Lincei—Rend., vii. (1891) pp. 151–3 (1 fig.).

being confined to Mammals, Sarcosporidia are now known to occur in the lizard, tortoise, and frog, and in the two Crustaceans mentioned above.

Conjugation and Spore-forming in Gregarines.*—Herr M. Wolters has studied *Monocystis agilis* and *M. magna* of the earthworm, *Clepsidrina blattarum* of the cockroach, and *Klossia* of the snail. In *Monocystis*, conjugation of living forms was observed. Peculiar changes in the form of the nucleus and an increase in the number of nucleoli are regarded as preparatory steps. The characteristic granules do not contain fat or lime-salts, but seem to be amyloid reserve-products. A cellular meshwork may be demonstrated by the use of reagents, but Wolters regards it as an artificial coagulation. The cyst of two conjugating individuals is sometimes surrounded by a membrane produced by the cells of the host. The nucleus of each unit forms a spindle; half is extruded as a "directive body"; a reconstruction takes place; a second sheath round the encysted pair becomes demonstrable; fusion takes place, both nuclear and cytoplasmic; the nuclei seem to separate again; then two spindles are seen in each half; then many spindles around the periphery. Each peripheral nucleus eventually becomes the centre of a sporogonium within which eight spores are formed around a residual core, the whole being surrounded by a sporocyst or pseudonavicella-sheath. The central body of the original cyst is gradually used up by the sporogonia. The development is the same in both species. Wolters describes some of the histological characters of *Clepsidrina*, especially in regard to the cuticle and its striæ. As in *Monocystis*, the nucleus changes its form and becomes stellate, while the chromatin elements also vary greatly at different stages. The conjugation and spore formation are briefly described, and the results corroborate those of Bütschli. The stellate stage of the nucleus in *Klossia* seems to be a preparation for division. Typical spindles like those of *Monocystis* were not demonstrable. Within the sporogonium there are often six spores, lying around a sporophore which gradually diminishes. Conjugation does not occur.

Parasitic Protozoid Organism in Cancer.†—Dr. Nils Sjöbring observed in sections of mammary cancer numerous peculiar bodies which appeared to represent different stages of development of a micro-organism belonging to the group Sporozoa. This organism passes the earlier part of its development within the nucleus of the cancer cells, and the later period either within the cell protoplasm or as a free wandering body. In its adult condition it exercises a pernicious influence on the tissues in which it lives. When fully developed the organism forms spores to the number of 20 to 30. Round about its soft body, the plasmodium, a membrane appears and germs are soon visible in its interior. The spores are surrounded by a common membrane. The germs are supposed to escape from their capsule by rupture of the investing membrane.

The author found this organism in six cases of carcinoma of the mamma, in one of the liver and of the prostate. Cultivations of the microbe failed.

* Arch. f. Mikr. Anat., xxxvii. (1891) pp. 99–138 (4 pls.).

† Fortschr. d. Medicin, 1890, No. 14. See Centralbl. f. Bakteriol. u. Parasitenk., viii. (1890) p. 731.

Protozoon- and Coccidium-like Micro-organisms in Cancer-cells.*—Dr. Schütz considers that the amœboid forms, observed by van Henkelom and Sjöbring in cancer-cells, which were supposed by those observers to be the cause of the epithelioid proliferation of the carcinoma tissue, are probably red blood-corpuscles, since they react in a similar manner to Flemming's staining method. Besides this, both Klebs and the author have noticed migrations of corpuscles from vessels into these cells, after which they undergo various changes of form.

The appearances described as sporocysts, the author thinks, are leucocytes which have undergone some peculiar change, and he holds that his opinion is confirmed by the absence of any observation of these appearances in fresh preparations of cancer tissue.

Myoparasites of Amphibia and Reptilia.†—From a further examination of his specimens with improved lenses, Prof. B. Danilewski now states that the myoparasites of Amphibia and Reptilia are Microsporidia; the muscle-fibres are distended with extremely small spores, which are extremely like Cornalia corpuscles, or Pébrine spores. The best examples of this disease are seen in the muscles of the posterior extremities of the frog, where they are commonly visible as whitish spindle-shaped streaks about 1–1·5 mm. long.

The parasitic bodies lie within the sarcolemma and consist of small (0·003–0·004 mm.) oval or ovate spores which consist of a sheath and protoplasmic contents. In the riper spores the central portion is more transparent than in the young, the sheath of which does not present a double contour.

The author proceeds to speculate whether there be any connection between Myosporidia and Hæmatozoa sporozoica.

* Münch. Med. Wochenschr., 1890, No. 35. See Centralbl. f. Bakteriol. u. Parasitenk., ix. (1891) pp. 285–6.

† Centralbl. f. Bakteriol. u. Parasitenk., ix. (1891) pp. 9–10.

BOTANY.

A. GENERAL, including the Anatomy and Physiology of the Phanerogamia.

α. Anatomy.

(1) Cell-structure and Protoplasm.

Protoplasmic Connection between adjacent Cells.* — Herr F. Kienitz-Gerloff enumerates a very large number of instances in which he has detected protoplasmic connection between adjacent cells:—Among Musci, all the cells of the stem of *Thuidium delicatulum*; among Filices, all the parenchymatous cells of the rhizome, the sieve-region of the vascular bundles, and the endoderm of *Polypodium vulgare*; among Coniferæ the bud-scales and cortex of *Abies pectinata*, the bud-scales of *Pinus excelsa*, the bud-scales and sieve-tubes of *Pinus sylvestris*; among Angiosperms, the cortical cells of the rhizome, the embryo- and endosperm-cells, the young leaves, the central vascular bundle of the root, the fundamental tissue of the stem, collenchyme, epiderm, pith, cambium, mesophyll of the leaf, sclerenchyme, hairs, and other organs and tissues of plants belonging to a great number of natural orders of both Monocotyledons and Dicotyledons.

These protoplasmic connections are not merely between cells belonging to the same tissue; they are even more common between adjacent cells belonging to entirely different tissues, as between epidermal cells and those of the cortex or collenchyme, and between the endoderm-cells and those of the primary parenchyme and of the vascular bundle in *Polypodium vulgare*. The author believes, in fact, that, in the higher plants, all the living portions of the entire plant are connected by threads of protoplasm. The perforation of sieve-tubes is simply an instance of this general law where the threads are of unusual thickness. In Phanerogams the thickness of these threads varies between 0·05 and 1·0 μ, while in *Thuidium delicatulum* they were measured as thick as 3 μ. The thicker threads are usually solitary; where they are thinner it is more common for a number to be collected together into a fusiform mass. In the opinion of the author no perforation of the cell-wall ever takes place; but, at the spot where the threads pass through, no cellulose is formed at the time of cell-division. The connecting threads appear to be the remains of the spindle-fibres formed in the process of division of the nucleus.

With respect to the physiological value of this protoplasmic connection, the author takes the view of those who regard the threads as the conducting path through which the protoplasm passes out of the vessels and sclerenchymatous fibres into the adjacent cells.

A very complete bibliography of the subject is appended.

Formation of Vacuoles.†—Dr. G. Klebs contests the soundness of de Vries' and Went's conclusion that vacuoles are in all cases formed by the division of others already in existence, a conclusion which has, he thinks, been in many cases arrived at by neglecting the evidence

* Bot. Ztg., xlix. (1891) pp. 1–10, 17–26, 33–46, 49–60, 65–74 (2 pls.).
† Op. cit., xlviii. (1890) pp. 549–59. Cf. this Journal, *ante*, p. 58.

of facts opposed to it. He finds that in *Hydrodictyon utriculatum* there is no simultaneous division of the protoplasts into zoospores, but that the first process is a peculiar breaking-up of the parietal layer of protoplasm into ribbon-shaped pieces, from the division of which the zoospores are formed. In this alga, as in *Botrydium granulatum*, the original vacuole of the mother-cell remains until the zoospores are mature, and there is no evidence of its breaking up into from 7000 to 20,000 small vacuoles, corresponding to the number of the zoospores. Klebs further points out that Went fails to indicate any method by which pathological can be distinguished from normal vacuoles.

Formation of Cell-wall in Protoplasts not containing a Nucleus.* —Herr E. Palla has made further observations which confirm his previous statement that it is possible for a cell-wall to be formed round protoplasm destitute of a nucleus. One series of experiments was made on pollen-grains—*Leucojum vernum*, *Galanthus nivalis*, *Scilla bifolia*, *Hyacinthus orientalis*, and others—causing them to germinate in a solution of sugar and gelatin, by which the extremity of the pollen-tube was ruptured, and both nuclei expelled. Although the part below usually perished, yet in many cases a fresh cap of cellulose was formed on the apical side. Similar results were obtained, by the process of plasmolysis with a 10 per cent. solution of sugar, with leaves of *Elodea canadensis*, root-hairs of *Sinapis alba*, rhizoids of *Marchantia polymorpha*, and filaments of *Œdogonium*. The author does not reject the hypothesis that the formation of cellulose in such cases may be a secondary result of the activity of the nucleus which was once present.

Antagonistic Molecular Forces in the Cell-nucleus.†—M. C. Degagny discusses the question whether the facts already described in the division of the cell-nucleus in *Spirogyra* prove the existence of an antagonism between the different chromatic portions of the nucleus. The first indication of the rupture of the equilibrium which reigns in the interior of the nucleus is its increase in volume; the nucleole then no longer occupies its central position, but becomes placed sometimes on one side, sometimes on the other, of the nucleus; this may be due to the entrance into it of the red granulations; for, before their appearance, it had remained in equilibrium. The separation of the nucleolar particles usually takes place slowly, but at other times the nucleole breaks up suddenly, and the red particles are projected, not in all directions, but all on the same side, and the nucleole itself is then driven in a direction opposite to that of the granulations, and a visible antagonism is thus manifested between the different portions of the chromatic substance of the nucleus. Evidence of a similar nature is presented in the formation of the nuclear membrane.

(2) Other Cell-contents (including Secretions).

Structure and Formation of Chromatophores.‡—Herr H. Bredow has investigated this subject, chiefly in connection with the development and germination of seeds. His observations agree with those of Tschirch,

* Flora, lxxiii. (1890) pp. 314–31 (1 pl.). Cf. this Journal, 1890, p. 475.

† Comptes Rendus, cxi. (1890) pp. 761–3. Cf. this Journal, *ante*, p. 58.

‡ Jahrb. f. Wiss. Bot. (Pringsheim), xxii. (1890) pp. 349–414.

as also in the main with those of Pringsheim, Meyer, Schimper, Schmitz, and F. Schwarz.

When the seeds are ripe the chlorophyll-grains do not become absorbed in the protoplasm, but only shrivel and dry up, and are then so concealed by the reserve-substances that they are difficult to detect. On germination the chlorophyll-grains again swell up, and multiply by a usually irregular division into four, so that the cells are filled with small particles which were formerly considered as microsomes of the protoplasm. In etiolated cotyledons the chromatophores develope in the same way as in green ones, but are somewhat smaller. Those cotyledons which are above the surface of the soil are not only receptacles for reserve-substances, but also organs for assimilation, since their chlorophyll-grains form starch. But they do not develope in the dark or in diffused daylight, but only in direct sunlight.

Experiments with Schwarz's reagents show that the stroma of the chlorophyll-grains does not consist of fibrillæ composed of granules and a matrix in which they are imbedded, but of a framework of bands, which holds the pigment in its meshes; these bands are in communication one with another. In by far the greater number of cases no protoplasmic membrane could be detected surrounding the chlorophyll-grains. In different plants, and even in the same species, the resistant power of the chromatophores varies greatly; some are completely destroyed even by water, while others resist much more powerful reagents.

Origin and Development of Starch-grains.*—Herr O. Eberdt criticizes the conclusions arrived at by previous observers on this subject, and especially those of Schimper.† His observations were made on the epiderm of the stem and leaf-stalk of *Philodendron grandifolium*, rhizome and tubers of *Canna*, *Stanhopea*, *Epipactis palustris*, *Convallaria majalis*, *Phajus grandifolius*, and the potato, and on the starch-grains in the laticiferous tubes of the Euphorbiaceæ.

The author agrees with Schimper in tracing the origin of the starch-grains in parts of plants which do not assimilate to proteinaceous bodies, which Schimper terms starch-generators, but which Eberdt prefers to call the ground-substance of starch. He dissents, however, from Schimper's view that these bodies play an active part in the formation of starch; and he regards them as purely passive bodies, while the active substance is the protoplasm solely. Again, while Schimper asserts that these plastids (leucoplastids, chloroplastids, or chromoplastids) are present in the cell from the first, Eberdt maintains that they are formed out of the protoplasm by differentiation.

These bodies have a tendency to move towards the cell-nucleus, and then either collect into groups or are scattered around it. In either case they are inclosed in a pellicle of protoplasm, which is connected by threads with the parietal protoplasm of the cell. When collected into groups, each one of these bodies becomes gradually transformed into starch from within outwards, and the protoplasm-pellicle then becomes detached, and finally incloses each separate group, or it is ruptured and the groups fall apart. In the former case the groups remain permanently

* Jahrb. f. Wiss. Bot. (Pringsheim), xxii. (1890) pp. 293–348 (2 pls.).

† Cf. this Journal, 1888, p. 71.

inclosed in protoplasm until the starch-grains are fully formed, and the separate grains then show no lamination; or they escape from it at an earlier period, and then become differentiated into concentric layers. In the latter case differentiation also takes place into either concentric or excentric layers; and these grains can no longer increase in size after they lie free in the cell-cavity.

When the proteinaceous bodies lie separately around the nucleus the protoplasm-pellicle also becomes detached, and a portion of it completely incloses each separate body. It is this protoplasm which brings about the transformation of the body into starch. When the newly-formed starch-grain has broken through the pellicle, the protoplasmic portion of the latter still remains attached in the form of a cap. Starch-grains which have been formed in this way always exhibit excentric lamination after they have broken through the pellicle. They can no longer increase in size after the loss of the cap.

It is therefore only to this pellicle or cap of protoplasm that the name starch-generator can properly be applied. Under the influence of light the portion of protoplasm which remains attached to the starch-grain, but not the ground-substance of the starch, may, in certain cases, become green.

M. E. Belzung* criticizes these remarks, pointing out that Eberdt does not agree with Schimper's view that the starch-grains found in the centre of the chlorophyll-corpuscles have a concentric structure, while those near the surface are excentric, and there is a decided divergence of views as to the function of the leucites. According to Schimper they are, briefly, the generators of starch, while Eberdt considers that there are two stages in the development of the starch-grain,—first, the transformation of the leucite into starch, and then the growth of the nucleus thus formed, and the differentiation of the concentric layers.

M. Belzung points out that the authors in question have conducted their researches on plants where there is a certain amount of complexity, owing to the presence of crystalloids, and that the true origin of starch ought to be sought for in the very young embryo.

Protein-crystalloids in the Cell-Nucleus of Flowering Plants.†—Herr A. Zimmermann finds protein-crystalloids to be much more common in the nucleus of the cells of flowering plants than has hitherto been supposed. They occur in plants belonging to many different natural orders, though in other nearly related species he was unable to detect them. They are not confined to any particular organs or tissue-systems; they were found most frequently in the tissue of the leaf and in the pericarp. The method employed for detecting the crystalloids was a double-staining of microtome-sections by hæmatoxylin and acid-fuchsin, by which the crystalloids were stained an intense red, the nucleole and framework of the nucleus blue-violet.

Localization of the Active Principles of the Cruciferæ.‡—M. L. Guignard finds that the composition of the various active principles of

* Journ. de Bot. (Morot), v. (1891) pp. 5–13. Cf. this Journal, 1888, p. 70.

† Ber. Deutsch. Bot. Gesell., viii. (1890) Gen.-Versamml. Heft, pp. 47–8.

‡ Journ. de Bot. (Morot), iv. (1890) pp. 385–94, 412–30, 435–55 (20 figs); and Comptes Rendus, cxi. (1890) pp. 920–3.

the Cruciferæ varies from species to species. Black mustard contains sinigrin besides the ferment myrosin, as also does the horse-radish; while white mustard contains sinalbin in place of sinigrin. The active principle of *Cochlearia officinalis* is isosulphocyanate of secondary butyric alcohol; while the root, the stem, and the seed of *Sisymbrium Alliaria* and *Thlaspi arvense* contain a mixture of sulphur and sulphocyanate of allyl. The following are the author's conclusions on his researches:—(1) Nearly all the Cruciferæ are provided with special cells which contain a particular ferment, myrosin. It is in the seed that these cells occur most abundantly. (2) When these cells are found in the root it is in either the cortical parenchyme or the parenchyme of the liber; in the stem it is generally in the pericycle; in the leaf in the pericycle of the foliar bundles; in the cotyledons the localization is the same as in the leaf. (3) These special cells can be immediately distinguished by the nature of their contents. Pure hydrochloric acid, under the influence of heat, gives them a violet coloration. (4) In the embryo these specialized cells are differentiated some time before the maturity of the seed. (5) Sometimes in certain seeds (*Lunaria*, &c.) the embryo is rich in the glucoside, while the ferment is contained almost exclusively in the integument. (6) The ferment appears to be identical in all members of the family. (7) The presence or absence of the specialized ferment-cells can be made use of for purposes of classification.

(3) Structure of Tissues.

Vascular System of Floral Organs.*—Rev. G. Henslow describes and figures the course of the vascular cords in the various parts of the flower in 34 different natural orders. No appreciable differences are to be detected between the cords or traces of a sepal, a petal, a stamen, or a carpel. They all consist of the same two elements—spiral vessels or tracheæ representing xylem, and sieve-tubes or soft bast constituting the phloem. The predominating arrangement in all the floral structures is for the spiral vessels to be either placed accurately in the centre of a cylinder of phloem or to be scattered irregularly through it. In the pedicel the arrangement of the cords characteristic respectively of the stem of Exogens and Endogens is frequently reversed. The system of cords formed in the wall of the ovary of the poppy, alternating with the placentas, originates quite freely from meristematic tissue imbedded in the parenchyme, and has no connection with any cords arising from the axis.

Pericycle and Peridesm.†—In astelic stems (i. e. without any central vascular cylinder) M. P. Van Tieghem proposes to designate the layer of cells or the tissue which, beneath the special endoderm, surrounds the phloem and xylem of each vascular bundle, the *peridesm*, instead of, as hitherto, the special pericycle. Where the astelic stem is also "dialydesmic," as in the Nymphæaceæ, some species of *Ranunculus*, *Ophioglossum*, and some species of *Equisetum*, the peridesms are independent, as are the vascular bundles; but when the stem is "gamodesmic,"

* Journ. Linn. Soc. (Bot.), xxviii. (1890) pp. 151–97 (10 pls.).
† Journ. de Bot. (Morot), iv. (1890) pp. 433–5.

as in *Botrychium*, *Helminthostachys*, and many species of *Equisetum*, the peridesms also coalesce; and when the fusion of the vascular bundles is complete, as in the two former genera, the general external peridesm simulates a pericycle, and gives the appearance of a monostelic stem. In *Marsilea*, many ferns, and some species of *Auricula*, we have a gamo-polystelic structure in which the pericycles are united into a general external and a general internal pericycle; a structure very liable to be confounded with the general external and general internal peridesm in the gamo-astelic structure.

Abnormal Formation of Secondary Tissues.*—Herr H. de Vries describes the mode of formation of secondary tissues in the following abnormal cases, viz.:—a flower-stalk three years old of *Pelargonium zonale;* formation of wood in potatoes; in turnips two years old; abnormal formation of wood under the influence of galls; excrescences in leaves. As a general rule, conducting organs like flower-stems and leaf-stalks only last so long as the organ which they have to bear; when, from any exceptional cause, the life of the latter is prolonged beyond its normal limits, then the formation of secondary tissue is incited in the part that bears it.

Sieve-septum of Vessels.†—Herr O. Rodham describes the occurrence of peculiar vessels in *Tecoma* which are traversed transversely by a septum perforated in a sieve-like manner. They are found both in the outer normal woody structure and in the inner wood formed out of the secondary meristem in the pith, several being sometimes seen in the same transverse section.

Order of Appearance of the Vessels in the Flowers of Tragopogon and Scorzonera.‡—M. A. Trécul states that if one follows the order of appearance of the vessels in the interior of the bracts of the involucre of *Tragopogon pratensis*, *porrifolius*, &c., one finds that the first vessel of the median vein commences free at the two ends in the middle region of the bract, or sometimes even higher. In the flower itself the vessels of the stigmatic branches are formed after those of the corolla, but before those of the style. It is only after the appearance of vessels in the parts of the flower already mentioned, that the parietal vessels of the inferior ovary are formed. These usually result from the basal prolongation of five bundles or original substaminal groups.

Independence of Fibro-vascular bundles in the appendicular organs.§—M. D. Clos applies the term *exoneurosis* to the separation of the veins in the appendicular organs of plants, and their emergence in the form of teeth, spines, or bristles. A good illustration of exoneurosis is furnished by the transformation of leaves into spines in the barberry, and various other examples are described, especially in the case of stipules. In addition to stipules, this phenomenon is most frequently displayed in submerged organs, in the organs in the immediate vicinity of the flower or of the inflorescence, and in the parts of the flower itself, especially in the sepals.

* Jahrb. f. Wiss. Bot. (Pringsheim), xxii. (1890) pp. 35–72 (2 pls.).
† Ber. Deutsch. Bot. Gesell., viii. (1890) pp. 188–90 (2 figs.).
‡ Comptes Rendus, cxi. (1890) pp. 327–33.
§ Mém. Acad. Sci. Toulouse, ii. (1890) pp. 218–67 (1 pl.).

Cortical Bundles in Genista.*—M. W. Russell states that in certain plants the foliar bundles, instead of passing directly from the central cylinder of the stem to the leaves, pass along in the cortex for several internodes. The author shows this to be the case in several species of the genus *Genista*.

Elliptically wound Tracheids.†—Mr. P. H. Dudley describes structures to which he gives this designation, and which he finds in trees growing in dense forests, where, for want of light, the lower branches die, are attacked by fungi, break off, and the scar is overgrown; the main purpose served is protection from the further attacks of fungi.

Anatomy of Saxifragaceæ.‡—M. M. Thouvenin has made an exhaustive examination of the comparative anatomy of the Saxifragaceæ, which he divides into ten tribes, viz.:—Saxifragaceæ, Francoeæ, Cunonieæ, Hydrangeæ, Brexieæ, Escallonieæ, Ribesieæ, Hamamelideæ, Brunieæ, and Cephaloteæ. Each of these ten tribes is treated separately, but their distinguishing anatomical characters are few, and subject to many exceptions. The only anatomical character which is common to the whole order is a negative one, the absence of an internal phloem. As a general rule, but subject to exceptions, the stomates are surrounded by irregularly arranged cells; the mechanical (i.e. the non-glandular) hairs are unicellular, there is no differentiated secreting system, and the deposits of calcium oxalate are in the form of rhomboidal prisms rather than of raphides. The affinities of the Saxifragaceæ with other orders are discussed, especially with the Crassulaceæ, Caprifoliaceæ, Rhamnaceæ, and Rosaceæ.

(4) Structure of Organs.

Morphology and Phylogeny of Gymnosperms.§—From an examination of a number of species belonging to different families, Dr. L. Celakovsky concludes that the female flowers of the Gymnosperms are always borne in the axils of scales (Deckblätter), and are arranged in spikes, the number in a spike varying greatly; only in *Gingko* are there also subtending leaves and bracts (Niederblätter). Only in the Taxeæ does the flowering shoot possess two or three pairs of scale-like bracts (Vorblätter). The flowering shoot is limited, and has no growing point or growing cone; what has hitherto been taken for this is a sterile carpid. The number of carpids in a flower varies between one and nine, three being the most common number, of which the central one is sterile and abortive; in the Podocarpeæ and Dammareæ there is usually only one. The ovule has either a double integument, or a single one the whole of which is homologous to the double one; and such ovules are therefore not strictly monochlamydeous. The carpid developes into a single ovule by reduction from cycad-like polymerous carpids.

Structure of the Rhizophoreæ.‖—Herr G. Karsten describes the structure of the mangrove-vegetation of the Dutch East Indies, consisting

* Bull. Soc. Bot. France, xxxvii. (1890) pp. 133–5.
† Journ. New York Micr. Soc., vi. (1890) pp. 110–4 (4 figs.).
‡ Ann. Sci. Nat. (Bot.), xii. (1890) pp. 1–174 (22 pls.).
§ Abh. Böhm. Gesell. Wiss., viii, 148 pp. See Oesterr. Bot. Zeitschr., xli. (1891) p. 14.
‖ Ber. Deutsch. Bot. Gesell., viii. (1890) Gen.-Versamml. Heft, pp. 49–56 (1 pl.).

of the genera *Rhizophora*, *Bruguiera*, *Ceriops*, and *Kandelia* belonging to the Rhizophoreæ, as well as others belonging to the Myrsinaceæ, Verbenaceæ, Myrtaceæ, Combretaceæ, Rubiaceæ, Meliaceæ, and Palmæ.

The ovules of all Rhizophoreæ possess, in their early stages, two integuments; but the inner integument frequently becomes more or less completely absorbed, and in *Bruguiera* the embryo-sac forces its way through it, and spreads itself out between the two layers. Of the 4-6 ovules in each flower all but one always abort. The embryo has two growing points, one of which penetrates the endosperm and bears 2-4 cotyledons, which soon fill up the entire cavity of the outer integument and act as absorbing organs, while the radicular growing point, which is directed towards the micropyle, breaks finally through it and developes into the hypocotyl. All the nutrient substances of the mother-plant are applied to the nutrition of this hypocotyl, which may attain a length of 1 metre.

The fruit (or seed) of all mangrove-plants floats on the water. The roots, which strike into soil saturated with water, are adapted for the interchange of gases, and serve, therefore, as organs of respiration. They are abundantly provided with lenticels, and are negatively geotropic.

Order of Succession of the Parts of the Flower.*—A series of observations on this subject by Herr K. Schumann leads him to the conclusion that the prevalent theory that the parts of the flower are formed in spiral succession is not tenable in the greater number of cases. In the Lobeliaceæ all the sepals always originate simultaneously, and the same is the case in many Campanulaceæ, Rubiaceæ, and Caprifoliaceæ, and in some species of *Acer* and *Abutilon*. The "superposition" of whorls is a distinguishing character of floral, as contrasted with vegetative, shoots, and is always the result of contact, and of adaptation to the space at command. Where an outer whorl appears later than an inner whorl, as in the Primulaceæ and Plumbagineæ, it is always the result of intercalation. There may be extra-axillary flowers, corresponding to extra-axillary leaf-buds. The author adopts Schwendener's view that purely mechanical influences outweigh all others in determining the early development of plant-members, whether axial, foliar, or floral.

Septal Glands of Kniphofia.†—Miss E. R. Saunders describes the nectar-glands on the septa of the ovary of several species of *Kniphofia* (Liliaceæ). Their minute structure is detailed, and their development traced from the earliest stage. The saccharine fluid which they exude in large quantities when mature appears to be formed out of the starch contained in them at earlier stages. This change is doubtless effected by the protoplasm, and is presumably due to some ferment action.

Development of Fleshy Pericarps.‡—M. A. G. Garcin has examined in detail the structure and development of the fleshy pericarp in a large number of berries and drupes. In the ripe berry the mesocarp may consist of one, two, three, or four layers, and there may or may not be a

* Neue Unters. üb. d. Blüten-anschluss (10 pls.), Leipzig, 1890. See Bot. Centralbl., xlv. (1891) p. 220.

† Ann. of Bot., v. (1890) pp. 11–25 (1 pl.).

‡ Ann. Sci. Nat. (Bot.), xii. (1890) pp. 175–401 (4 pls.).

distinct hypoderm. In drupes the flesh is rarely homogeneous; when heterogeneous, it may be formed of one, two, or three layers. The stone is composed, independently of the fibrovascular bundles, of five distinct elements, viz. sclerotic cells properly so-called, sclerotic fibres, sclerotic tabular cells, sclerotic tubular cells, and parenchyme. The development of these various elements is traced; and a large number of examples are then described in detail, as regards both the ovary and the mature fruit.

Integument of the Seed of Cyclospermæ.*—M. L. Meunier has made an exhaustive examination of the structure and development of the integument of the seed of the Cyclospermæ (Chenopodiaceæ, Phytolaccaceæ, Aizoaceæ, Illecebreæ, Portulacaceæ, and Caryophylleæ), characterized by having a curved embryo buried in a copious endosperm. He distinguishes two types, viz.:—(1) The *chenopodic* type (Chenopodieæ, Baselleæ, Amaranthæ, Gomphreneæ, and Celosieæ). The membrane of the cells, which are in general prismatic, takes, exclusively of its external surface, a thickening which is often considerable, and is composed of a number of bars, usually parallel, having their base in the external cuticle, and descending more or less deeply into the secondary membrane. The same type occurs with modifications also in the Aizoaceæ, Illecebraceæ, Phytolaccaceæ, and Portulacaceæ. (2) The *caryophyllic* type (Caryophylleæ). The epidermal cells have a wavy and not a polygonal outline, and the cuticle is often remarkably sculptured. The outer membrane has not the stalactite structure of the Chenopodieæ, but is remarkably thick, and is furnished with singular prolongations of cellulose which descend into the cell-cavity. The variations of these two types are described in detail in all the genera included in the group.

Stomates.†—Prof. A. Weiss gives details of the distribution, form, and measurements of the stomates in several hundred species belonging to a great number of different families.

Rudimentary Stomates in Aquatic Plants.‡—M. C. Sauvageau describes structures which occur frequently in the leaves of aquatic plants, both freshwater and marine, similar to those already known in the case of *Callitriche*. They consist of a depression on the upper side of the leaf near the apex of the mid-vein, which places the inner conducting system in connection with the external air, and which may be regarded therefore as aquiferous stomates. They are formed by the separation of epidermal cells, and occur in all species of *Potamogeton* examined, in *Zostera*, *Halodule*, and *Phyllospadix*, but not in other marine genera.

Metamorphosis of Vegetative Shoots in the Mistletoe.§—Herr E. Loew describes two abnormal metamorphoses of vegetative shoots into flowers in the mistletoe. In the first the three-flowered axillary shoot was suppressed, and in its place the foliage-leaves and bracts had become transformed into perianth-leaves. In the second instance the two lateral

* La Cellule, vi. (1890) pp. 299–392 (7 pls.).
† SB. K. Akad. Wiss. Wien, xcix. (1890) pp. 307–82 (2 pls.).
‡ Comptes Rendus, cxi. (1890) pp. 313–5.
§ Bot. Ztg., xlviii. (1890) pp. 566–73 (2 figs.).

flowers of the inflorescence were suppressed, but the lateral buds were each transformed into a flower. Both the examples were male plants.

Leaves of Lotus.*—M. P. Vuillemin states that the assimilating tissue of the lamina of leaves is usually bifacial with long palisade-cells on the upper, and spongy tissue on the under side; *Lotus corniculatus* is a good example of this. It is necessary, however, to contrast with this *L. villosus*, *L. pusillus*, &c., where the green parenchyme is uniformly spongy, and *L. arenarius* and *L. sessilifolius*, where there are short palisade-cells on both surfaces. The epidermal cells of the lamina are flat or spherical, and polygonal or sinuous in contour. Except in *L. glaberrimus* and *Delestrei*, the leaves of the species of *Lotus* are provided with hairs composed of three cells.

Production of Bulbils in Lilium auratum.†—M. P. Duchartre states that the production of bulbils has already been described in *Lilium Thomsonianum*. In *L. auratum* it was noticed that when the bulb was taken from the soil the scales were becoming proliferous. The external face of these scales was not in any way peculiar, but the internal face gave rise to numerous bulbils; these were spread over the surface in two different ways. Two of the most developed bulbils were generally to be found at the base of the scale, while the others occupied a higher position and were attached on the median line.

Nodosities on the Roots of Leguminosæ.‡—From a series of experiments in inoculating plants of *Pisum sativum* from infected specimens of various other Leguminosæ, M. E. Laurent arrives at the conclusion that the nodules are caused by the attacks of a microbe (not necessarily a bacterium), and that there is not a special microbe for each species, since infection can take place from one species of Leguminosæ to another. He further confirms the statement of earlier writers that the tendency towards the production of tubercles on the roots is in inverse proportion to the amount of nitrogen contained in the nutrient fluid.

Filaments in the Root-tubercles of Leguminosæ.§—Herr A. Koch has determined that the filiform bodies which infest the root-tubercles of various Leguminosæ possess a true cellulose-membrane, though the reaction with chlor-zinc-iodide can only be made out with certainty, after removing their contents, by laying thin sections for some hours in eau-de-Javelle. He does not consider that this necessarily negatives the hypothesis of their bacterioid nature, since several true bacteria possess a cellulose-membrane, notably *Sarcina ventriculi*, and the vinegar-bacteria. The observations were made on the following species of Leguminosæ:—*Vicia Faba*, *V. narbonensis*, *Robinia Pseud-acacia*, *Trifolium pratense*, *Medicago lupulina*, *Pisum sativum*, *Lens esculenta*, and *Onobrychis sativa*.

* Bull. Soc. Bot. France, xxxvii. (1890) pp. 206–13. † T. c., pp. 234–6.
‡ Bull. Acad. R. Sci. Belgique, xix. (1890) pp. 764–71 (1 pl.). Cf. this Journal, 1890, p. 372.
§ Bot. Ztg., xlviii. (1890) pp. 607–15.

β. Physiology.

(1) Reproduction and Germination.

Sexual Forms of Catasetum.*—Mr. R. A. Rolfe points out that Darwin was in error in describing a hermaphrodite as well as a male and female form of *Catasetum tridentatum*, the so-called hermaphrodite form being really male. Lindley's genus *Myanthus* must be sunk in *Catasetum*, while the same author's *Monachanthus viridis* represents the female form of three distinct species, viz. *Catasetum barbatum*, *cernuum*, and *macrocarpum*. In this genus, while the male forms of some species differ widely, the female forms are remarkably alike. The author finally enumerates the species of *Catasetum* of which both sexes are known, sixteen in all, and subdivides the genus into four sections, of which three are diœcious and one hermaphrodite.

Germination within the Pericarp in Cactaceæ.†—M. D. Clos describes the seeds of a species of *Pereskia* (Cactaceæ) from Martinique, which germinate normally within the pericarp; for which purpose the hypocotyl is provided at its base with a small cone, which fixes itself to the wall of the pericarp by a network of white filaments formed of narrow hyaline cells. By this means nutriment is obtained for the germinating seed from the decaying pericarp.

(2) Nutrition and Growth (including Movements of Fluids).

Increase in thickness of the Coniferæ.‡—Herr K. Mischke has investigated the mode of increase in diameter of the stem, especially in *Pinus sylvestris*. The initial cambium-cell divides, and gives off cells in the direction of the xylem and of the phloem, which again divide once or twice according to the vigour of the growth; where the growth is very sluggish, the cells which spring immediately from these initial cells are differentiated into elements of the xylem and of the phloem. Those which are given off towards the xylem develope into tracheids. The cambium forms a cylindrical layer, bounded on the inside by a xylem-, on the outside by a phloem-cylinder. A remarkable irregularity was observed in the growth of a specimen of *Picea excelsa*. Commencing in the middle of April, it attained one maximum of intensity about the beginning of June, from which it rapidly sank to zero at the commencement of July; from the middle of July it again rapidly rose, and reached a second maximum, still higher than the first, about the middle of August, falling again to zero by the end of that month.

Parasitism of Euphrasia.§—Pursuing his investigation of the life-history of the Rhinanthaceæ, Herr L. Koch finds *Euphrasia officinalis* to be a true and not merely a facultative parasite, and the phenomena to correspond in general terms with those of *Rhinanthus minor*. It is parasitic on the roots (but not on the rhizome) of grasses, and chiefly on the very finest roots, in which the vascular bundle has not become

* Journ. Linn. Soc. (Bot.), xxvii. (1890) pp. 206–25 (1 pl.).
† Comptes Rendus, cxi. (1890) pp. 954–6.
‡ Bot. Centralbl., xciv. (1890) pp. 39–45, 65–71, 97–102, 137–42, 169–75 (8 figs.).
§ Jahrb. f. Wiss. Bot. (Pringsheim), xxii. (1890) pp. 1–34 (1 pl.). Cf. this Journal, 1889, p. 665.

differentiated beyond the condition of a procambial string, differing in this respect from *Rhinanthus major*. When the seeds germinate without access to the host-plant immediately after germination, they never attain any considerable size or vigour. The haustoria of *Euphrasia* are exceedingly minute, and are best detected by the method of paraffin imbedding recommended by the author.* The initial-cells of the parasite which attack the host-plant commonly penetrate between the cells of the epiderm; the resulting tissue advancing towards and into the vascular bundle of the root. The result of the attack of the parasite is distinctly injurious to the host-plant: and, during the latter portion of its existence, the mode of life of *Euphrasia* is to a large extent saprophytic on the products of the decay of the tissue of the host-plant caused by its attacks. *Euphrasia officinalis* is very seldom parasitic on any plant not belonging to the Gramineæ.

Formation and Transport of Carbohydrates.†—Herr W. Saposchnikoff has studied these phenomena, especially in the cases of *Helianthus annuus* and *Cucurbita Pepo*. He finds the decrease of their amount when leaves are deprived of light to be only one-fifth in cut leaves compared to what it is in leaves still attached to the plant. The energy of this process shows a daily periodicity which reaches its maximum between 7.30 and 9.30 p.m., and its minimum between 12 and 5.30 p.m.; the maximum being at an earlier period of the day than the maximum of growth. The presence of glucose in the cells hinders the action of the ferment in the further conversion of sugar into glucose. The author found the energy of the formation of carbohydrates in the leaves to be greatly influenced by the weather, being very much greater with a clear sky and a large amount of light. With the increase of the amount of carbohydrates in the leaves, the energy of assimilation proportionately decreases. It is obvious, from quantitative experiments, that the whole of the carbon of the decomposed carbon dioxide is not used up in the formation of carbohydrates; there must be a second primary or secondary product of assimilation, which is probably an albuminoid.

Assimilation of Nitrogen by Plants.‡—From experiments, chiefly on leguminous plants, Herren B. Frank and R. Otto have determined that green leaves contain more nitrogen in the evening than the following morning, and this appears to depend on the quantity of asparagin being larger. Asparagin and sugar are the best nutrients for the symbiosis-fungus (*Rhizobium*) of the Leguminosæ. The larger proportion of nitrogen present in the evening was most striking in *Trifolium pratense*, *Medicago sativa*, and *Lathyrus sylvestris*, but was observable also, though to a smaller degree, in plants belonging to other natural orders.

Effect of Transpiration on Etiolated Plants.§—Prof. W. Palladin explains the effect of light in retarding the growth of plants (i. e. in shortening the internodes) by the fact that it greatly increases transpiration. From observations made on the dried weight, as compared with the fresh weight, of the leaves of various plants, he concludes that etiolated leaves may be divided into two groups,—when sessile they

* Cf. this Journal, 1890, p. 674.
† Ber. Deutsch. Bot. Gesell., viii. (1890) pp. 233–42.
‡ T. c., pp. 331–42.
§ T. c., pp. 364–71.

contain more, when stalked they contain considerably less water than green leaves of the same species.

In another communication * on the same subject, Prof. Palladin states that etiolated leaves (of wheat) which have grown to an abnormal length contain more water than those that are green; while the reverse is the case with small leaves. The large young leaves near the apex of the stem, under the influence of light and transpiration, abstract water from the stem, which therefore grows slowly. In the dark, on the other hand, transpiration being arrested, the leaves do not grow so fast, while the stem grows faster.

Ascending and descending Current in Plants.†—Herr J. Boehm adduces confirmation of his previous views on this subject from experiments on a sunflower cut down at the second internode. The capillary interstices of the soil and of the plant form a continuous system through which the water is conveyed to the transpiring leaves. When the soil is comparatively dry, and the sap-conducting vessels remain permanently filled with water, there must be a current of water descending from these into the soil.

Internal Atmosphere of Tubers and Tuberous Roots.‡ — M. H. Devaux states that the exchanges of gases in tubers and tuberous roots are produced in three different ways, which ordinarily coexist: — (1) There is transmission by diffusion of free gases through the pores of the periderm-envelope, (2) Transmission by diffusion through the membrane, the gas being dissolved; (3) Transmission by a strong gaseous current through the pores of the envelope.

M. Devaux § further describes an apparatus which illustrates the gaseous changes that take place in a tuber. Briefly, it consists of a bell, the orifice of which is covered with a piece of vegetable parchment, and thus represents fairly well a tuber reduced to its external pellicle. It is then subjected to analogous conditions to those of the internal mass of the tuber, with the following results:— (1) When the membrane is dry, (*a*) the carbon dioxide increases in the internal atmosphere, (*b*) the oxygen penetrates by diffusion, (*c*) the nitrogen is in smaller proportion than in the external air, (*d*) the pressure of the internal gas is greater than that of the air. (2) When the membrane is wet, (*a*) the carbon dioxide diminishes rapidly, (*b*) the oxygen diminishes, (*c*) the nitrogen increases rapidly.

(3) Irritability.

Sensitive Stamens and Stigmas.‖ —Prof. A. Hansgirg classifies the numerous examples of irritability in the stamens and stigmas which subserves the process of pollination, under the following five types, viz.:— (1) *Cactaceæ*-type: the numerous filaments are nearly equally sensitive on all sides, and curve centripetally, bringing the anthers towards the stigma; the contractile parenchymatous tissue is well developed only in

* Arb. Naturf.-Ver. Charkow, xxv. (1890) 5 pp. (Russian). See Bot. Centralbl., xlv. (1891) p. 279.

† Ber. Deutsch. Bot. Gesell., viii. (1890) pp. 311–4, and SB. K. K. Zool.-Bot. Gesell. Wien, xl. (1890) pp. 55–6. Cf. this Journal, 1890, p. 632.

‡ Bull. Soc. Bot. France, xxxvii. (1890) pp. 272–9.

§ T. c., pp. 257–64.

‖ Bot. Centralbl., xliii. (1890) pp. 409–16.

the lower and most sensitive part of the filament (*Opuntia*); (2) *Cynaraceæ*-type: the five syngenesious stamens are epipetalous, the filaments are sensitive on all sides and for their whole length; when at rest they are curved outwards; when irritated they contract and become nearly straight; the contractile tissue penetrates the whole of the filament (many Compositæ); (3) *Cistineæ* and *Mesembryanthemaceæ*-type: the numerous free filaments are sensitive on all sides, but most so on the outer side; when irritated they bend centrifugally towards the corolla (*Helianthemum*, *Cistus*, *Mesembryanthemum*); (4) *Tiliaceæ* and *Portulacaceæ*-type: the numerous filaments are sensitive on all sides, but chiefly on the outer side, and become concave on the irritated side (*Sparmannia*, *Portulaca*); (5) *Berberideæ*-type: the six free filaments are sensitive only on the inner side, and only immediately above their insertion and immediately beneath the anthers; the curvature is centripetal and brings the anther into contact with the stigma (*Berberis*, *Mahonia*).

There is, on the other hand, no such difference in the structure or in the seat of the sensitiveness in irritable stigmas; they are found in the orders Scrophulariaceæ, Pedalineæ, Acanthaceæ, Bignoniaceæ, and Cappariderе.

A list is appended of those species in which the flower opens only once and then closes, and of those in which it opens and closes more than once.

In a subsequent communication * Dr. Hansgirg adds considerably to the list, and enumerates other examples of types (1)-(4). To type (4) belong several species of *Abutilon*, but sensitive stamens or stigmas were not observed in any other plants belonging to the Malvaceæ.

The author adds further remarks on the flowers which he terms "pseudo-cleistogamic," i. e. those which resemble the ordinary flowers in every respect except that they do not open, and are self-fertilized; presenting thus an intermediate condition between ordinary and truly cleistogamic flowers. A list is appended.

Nyctitropic Movements of Leaves.†—Prof. A. Hansgirg enumerates a large number of species of flowering plants which display nyctitropic movements of the leaves or leaflets, in which the phenomenon had not previously been recorded. As in the case of carpotropic, so with nyctitropic movements, it is not uncommon for nearly allied species to differ from one another in their presence or absence. The author arranges the genera in which the leaves display conspicuous nyctitropic, frequently accompanied by sensitive, movements, under a number of types, the primary distinction depending on the presence or absence of motile cushions at the base of the leaf or leaflet.

Carpotropic Curvatures of Nutation.‡—By this term Prof. A. Hansgirg designates those movements of the fruit-stalk, or of the sepals or bracts, which are designed for the protection of the ripe fruit, or to promote the dissemination of the mature seeds. They are not so dependent on the daily alternations of temperature as are the gamotropic

* Op. cit., xlv. (1891) pp. 70–5.

† Ber. Deutsch Bot. Gesell., viii. (1890) pp. 355–64. Cf. this Journal, 1890, p. 484.

‡ Ber. Deutsch. Bot. Gesell., viii. (1890) pp. 345–55.

and nyctitropic movements of the floral organs. As regards the foliar organs of the flower, they can, of course, occur only where these persist till the ripening of the fruit, and do not always even in these cases. A very large number of instances are adduced by the author. It is not uncommon to find, in the same genus, some species the calyx of which displays carpotropic movements, and others nearly allied, where it is wanting, as in the genera *Rubus*, *Rosa*, and *Potentilla*. In some cases these carpotropic movements are simply passive, while in others they depend on growth, and are the result of epinasty and hyponasty. The burying of some fruits in the soil while they are ripening is the result of carpotropic movements of the fruit-stalk.

Influence of Gravitation on the Sleep-movements of Leaves.*—Herr A. Koch finds, in the trifoliolate leaves of *Phaseolus vulgaris*, a nyctitropic elevation of the leaf-stalk amounting to about 15°, and depression of the lamina to the extent of from 70° to 120°. By experimenting with the clinostat, he found that rotation round a horizontal axis entirely prevented this nyctitropic movement, or at least reduced it to a minimum. The same was the case also with *Phaseolus multiflorus*, *P. tumidus*, *Lupinus albus*, and *Gossypium arboreum*. With other plants, on the other hand, which exhibit nyctitropic movements—e. g. *Trifolium pratense*, *Portulaca sativa*, *Cassia marylandica*, *Goodia obtusifolia*, *Oxalis lasiandra*, and *Acacia lophantha*, the removal of the action of gravitation by horizontal rotation produced no change in these movements. We have therefore two classes of nyctitropic plants; for the first the author proposes the term *geo-nyctitropic*, for the second and more numerous class, *auto-nyctitropic*.

Heliotropism and Geotropism in Mosses.†—M. E. Bastit shows, from the result of experiments on *Polytrichum juniperinum*, that the phenomena of heliotropism and geotropism manifest themselves in Mosses in the same way as in the higher plants. When grown either in air or in water, the heliotropic influence on the growth of the stem of Mosses exceeds that of geotropism; the stem always directs its growth towards the light, whatever may be the position of the source of illumination.

(4) Chemical Changes (including Respiration and Fermentation).

Influence of Anæsthetics on Assimilation and Transpiration.‡—In confirmation of his previous views with regard to the relationship between assimilation and transpiration, M. H. Jumelle finds that anæsthetics increase transpiration in plants exposed to light, when the dose is sufficient to suspend respiration. This increase is due to the action of the ether on the chlorophyll-bodies. When, by any means, assimilation is arrested without suppressing the absorption of the rays of heat by the chlorophyll, all the energy of these rays is transferred to transpiration, and accelerates it.

* Bot. Ztg., xlviii. (1890) pp. 673–83, 689–701, 705–18.

† Comptes Rendus, cxi. (1890) pp. 841–3.

‡ Rev. Gén. de Bot. (Bonnier), ii. (1890) pp. 417–32 (1 pl.); and Comptes Rendus, cxi. (1890) pp. 461–3. Cf. this Journal, 1889, p. 669.

Respiration of Plants.*—Herr W. Detmer finds, in the case of wheat, that the optimum temperature for respiration is between 35° and 40° C., the minimum being below zero. Respiration ceases with death, any production of carbon dioxide after this being due to the presence of bacteria. When oxygen is excluded, an active decomposition of the albuminoids takes place, the resulting products being amides and amido-acids.

Respiration and Fermentation of Yeast.†—MM. Gréhant and Quinquad find, from a long series of experiments, that notable quantities of gas are included in yeast, especially carbon dioxide and nitrogen. When yeast respires at a temperature between 8° and 15° C., the quantity of carbon dioxide produced is less than the quantity of oxygen absorbed, or the proportion $\frac{CO_2}{O}$ is less than unity. Respiration does not cease even at zero, and the proportion becomes then nearly unity. At a temperature between 15° and 18°, the value of $\frac{CO_2}{O}$ is unity or higher; at 40°–50° it reaches two or more; one of the effects of a high temperature is to increase the production of CO_2. The respiration of yeast decreases in intensity when the temperature of the atmosphere is above 50°, and the proportion $\frac{CO_2}{O}$ falls again below unity. In the entire absence of oxygen, yeast can produce large quantities of carbon dioxide, borrowing the elements from its own tissue. Yeast absorbs the same quantity of oxygen when it produces fermentation as when it respires under simple conditions without fermentation. Fermentation can proceed rapidly in a vacuum with a temperature of 40°.

Lactase, a new Enzyme.‡—According to Herr M. W. Beyerinck, there are two ferments which ferment sugar of milk, *Bacillus caucasicus*, which exists in Kefyr, and a *Saccharomyces*, which he names *S. tyrocola*, which is found in Edam cheese, and which has been erroneously identified with *S. cerevisiæ* and with *S. Kefyr*; it differs from the latter in its form, being more nearly allied to *S. lactis*. He states that the fermentation is effected by a diastase distinct from invertin, which he calls *lactase*. It has no effect on the luminosity of *Photobacterium phosphorescens*, while glucose and galactose increase its luminous property. The invertin of *S. ellipsoideus* has no effect on sugar of milk, while *S. Kefyr* and *S. tyrocola* produce a diastase which inverts that sugar.

Nitrifying Process and its Specific Ferment.§—Prof. P. F. and Mrs. G. C. Frankland have made an investigation into the process of nitrification, the principal results of which are these:—They have succeeded, by the method of fractional dilution, in isolating a micro-organism present in ammoniacal solutions which were undergoing a nitrification which was originally induced by a minute quantity of garden soil. This organism is a very short bacillus, about 8 μ long, hardly longer

* Ber. Deutsch. Bot. Gesell., viii. (1890) pp. 226-30.
† Ann. Sci. Nat. (Zool.), x. (1890) pp. 269–328.
‡ Centralbl. f. Bakteriol. u. Parasitenk., vi. (1890) p. 44.
§ Phil. Trans., 181 B. (1891) pp. 107–28.

than broad, and exhibits only vibratory motion; it can be cultivated in suitable ammoniacal solutions to which no organic matter whatsoever has been added. In these solutions the growth of the micro-organism is accompanied by the gradual transformation of the ammoniacal into nitrous nitrogen; in solutions inoculated with the pure growth no formation of any nitric nitrogen has yet been observed. Solutions thus nitrified remain perfectly transparent and pellucid. Though pure nitrifying solutions have as yet yielded no growth in gelatin-peptone, the authors have not abandoned the hope of cultivating the nitrifying organism on this and possibly other solid media.

γ. General.

Digestive Properties of Nepenthes.*—M. R. Dubois has come to the conclusion, from an examination of the fluid contained in the pitchers of a large number of species of *Nepenthes*, that the carnivorous habits ascribed to the plant are the result of erroneous observation; that the liquid contains no digestive substance analogous to pepsin; and that the phenomena of digestion attributed to it are due to the presence of microbes, and not to any secretion of the plant.

Absorption of Rain by Plants.†—Pursuing his investigations on the adaptations of plants to rain and dew, Herr A. N. Lundström replies to the objections to his views brought forward by Kny and Wille,‡ and describes further observations on *Stellaria media* and on several species of *Tradescantia*, in which the internodes are furnished with lines of hairs which serve to convey the moisture of the air either to aërial or to underground roots, the former being often very difficult to detect. Although the quantity of water thus absorbed by the aerial parts is very inconsiderable compared to that taken up by the roots, it may be of considerable importance to the life of the plant.

When water falls on a leaf it may be seen to pass along the course of the veins, leaving the rest of the surface comparatively dry.

Kirchner's Diseases and Injuries of Plants.§—Herr O. Kirchner deals in his excellent manual with the diseases and injuries of plants cultivated by farmers, market gardeners, &c. To them, therefore, this work chiefly appeals, although the botanist and zoologist may be indebted to it. The work is divided into two sections; the first of these deals with the various plants met with in North and Mid-Europe and the diseases to which they are liable, and the diagnosis, treatment, and prevention of these maladies. The second portion of the work describes the various animal and vegetable organisms alluded to in the first part as causing or being connected with the various diseases.

* Comptes Rendus, cxi. (1890) pp. 315-7.

† Bot. Sekt. Naturw. Studentsällsk. Upsala, Dec. 11, 1888. See Bot. Centralbl., xliv. (1890) pp. 391 and 424; xlv. (1891) pp. 7, 41, and 76. Cf. this Journal, 1887, p. 119.

‡ Cf. this Journal, 1887, p. 995.

§ Stuttgart, 1890, 637 pp. See Centralbl. f. Bakteriol. u. Parasitenk., ix. (1891) pp. 22-3.

B. CRYPTOGAMIA.

Cryptogamia Vascularia.

Structure of Isoetes.*—Mr. J. B. Farmer has subjected both the sporophyte and the oophyte of *Isoetes lacustris* to a careful examination. He shows that the statement of Hofmeister and others that the apices of the stem and root grow by means of apical cells, is founded on a misconception of the structure. Also that the existence of a ligule in both *Isoetes* and *Selaginella* must not be taken as indicating a close affinity between these two genera. The mature structure of the ligule is different in the two genera, and that of *Selaginella* arises from a multicellular protuberance, not from a single cell as in *Isoetes*.

As regards the structure of the oophyte, the author differs from Pfeffer's view, who regards the upper small-celled portion of the products of division of the megaspore, above the first diaphragm, as constituting by itself the prothallium, and compares the lower and looser mass of cells below the diaphragm to the endosperm of Angiosperms. Farmer maintains that they are both parts of the true prothallium, the former being the specially reproductive, the latter the specially nutritive portion of that structure. He then further traces the resemblance between the processes which take place within the megaspore of *Selaginella* and *Isoetes*, and those which occur in the embryo-sac of Angiosperms.

Stem of Equisetaceæ.†—M. P. Van Tieghem proposes a rearrangement of the species of *Equisetum* according to the characters derived by Pfitzer from the endoderm (Schutzscheide) under five types, viz.:—(1) Special endoderms in the rhizome and aerial stem (*E. limosum*, *litorale*, *giganteum*, *pyramidale*, *debile*, *Martii*, *xylochætum*); (2) Special endoderms in the rhizome, two general endoderms in the aerial stem (*E. hyemale*, *trachyodon*, *ramosissimum*, *myriochætum*, *robustum*, *lævigatum*, *Schaffneri*; (3) Two general endoderms in the rhizome and in the aerial stem (*E. variegatum*); (4) Two general endoderms in the rhizome, one general external endoderm in the aerial stem (*E. sylvaticum*); (5) One general external endoderm in the rhizome (*E. arvense*, *maximum*, *pratense*, *palustre*, *scirpoides*, *bogotense*, *diffusum*).

The pericycle, which is always present and always simple, follows step by step the endoderm in all its modifications; and there are therefore three general types of pericycle and endoderm, viz.—(1) Special pericycles and endoderms; (2) two general pericycles and endoderms; (3) one distinct general external pericycle and endoderm. It is only in the first of these three modes that the stem possesses its typical structure, identical with that met with in many Phanerogams. In the second mode the structure is still astelic (without central cylinder); but there is lateral fusion of the pericycles and endoderm, although not always of the vascular bundles; and this may be termed *gamodesmic* in contrast to the typical *dialydesmic* structure. In the third mode the structure is also astelic. The astelic stem is then a general characteristic of the Equisetaceæ, in contrast to the polystelic (gamostelic or dialystelic) stem of most Filices and Hydropterideæ.

* Ann. of Bot., v. (1890) pp. 37–62 (2 pls. and 1 fig.). Cf. this Journal, 1890, 636.

† Journ. de Bot. (Morot), iv. (1890) pp. 365–73.

This grouping of the species of *Equisetum* according to the structure of the stem in no way corresponds to that of Milde founded on the nature of the stomates.

Muscineæ.

Sporophyte of Splachnum.*—The late Mr. J. R. Vaizey describes the structure of the remarkable umbrella-shaped apophyse of *Splachnum luteum* and other species. The parenchymatous tissue of the apophyse contains large numbers of chlorophyll-bodies, and the author has no doubt that this organ performs the function of a leaf; large quantities of starch being formed in its cells, which subsequently disappears. Its upper surface has a number of stomates the structure of which resembles in several respects those of flowering plants rather than those of other mosses. The structure of the sporange is typical; but the radial walls of the cells of the peristome have remarkable horizontal thickenings, recalling the thickenings in the elaters and cells of the walls of the sporange of many Hepaticæ.

Rabenhorst's Cryptogamic Flora of Germany (Mosses). — The last three parts of this publication, by Herr K. G. Limpricht, treat of the following orders:—Orthotrichaceæ, including *Amphidium* (2 sp.), *Zygodon* (9 sp.), *Ulota* (11 sp.), and *Orthotrichum* (38 sp.); Encalyptaceæ, including *Encalypta* (12 sp.), and *Merceya* (1 sp.); Georgiaceæ, including *Georgia* (1 sp.) and *Tetrodontium* (1 sp.); Schistostegaceæ (1 sp.); Splachnaceæ, including *Dissodon* (3 sp.), *Tayloria* (5 sp.), *Tetraplodon* (4 sp.), and *Splachnum* (3 sp.); Disceliaceæ (1 sp.); and the commencement of Funariaceæ, including *Pyramidula* (1 sp.), *Physcomitrium* (4 sp.), and *Entosthodon* (4 sp.). The characters of the genera and of many of the species are illustrated by the usual beautiful woodcuts.

Algæ.

British Marine Algæ.†—MM. E. M. Holmes and E. A. L. Batters print a complete list of all the British species of marine algæ that have at present been identified. Their distribution is indicated by a record of their occurrence in the fourteen sections into which the British coasts are divided, viz. nine for Great Britain and five for Ireland.

Lemaneaceæ.‡—Herr F. Bornemann gives a monograph of this order of Algæ, and describes two new species, *Sacheria rubra* and *S. cæspitosa*. He regards the *Chantransia*-form as a thallus, and the *Lemanea*-form as the fructification. This has usually a lateral, rarely a terminal, position. The fructification may display either true or false branching. The author describes the procarp as four-celled, two or three of the inner carpogonous cells developing into longer or shorter usually branched filaments, from the apices of which the spores are abstricted.

* Ann. of Bot., v. (1890) pp. 1–10 (2 pls.). Cf. this Journal, 1888, p. 460.

† Ann. of Bot., v. (1890) pp. 63–107.

‡ 'Beitr. z. Kenntniss d. Lemaneaceen,' Berlin, 1887, 49 pp. and 3 pls. See Just's Bot. Jahresber., xvi. (1890) p. 161. Cf. this Journal, 1890, p. 641.

Tuomeya fluviatilis.*—Mr. W. A. Setchell describes the structure and development of *Tuomeya fluviatilis* Harv. (*Baileya americana* Ktz.) which, both in its vegetative organs and its mode of fertilization, forms a connecting link between *Lemanea* and *Batrachospermum*. Young plants put out filaments resembling the *Chantransia* form of *Batrachospermum*. The antherids are developed from the terminal cells of the antheridial branches, and each produces a single antherozoid, which moves about for a short time with an amœboid motion, but soon becomes spherical and motionless. The carpogonial branches become at length spiral, and the procarps are formed from their terminal cells. The contents of the antherozoids enter the trichogyne through an opening in its wall; and the trichophore then produces chains of carpospores resembling those of *Batrachospermum*.

Structure of Zonaria.†—Mr. H. M. Richards describes the structure and development of the thallus of *Zonaria variegata* from Bermuda. It grows by the division of a marginal row of brick-shaped cells, and consists, in its most fully developed parts, of from five to nine layers of large medullary and two layers of cortical cells. Each initial cell of the superficial layers is soon divided into a large number of small cells. The concentric lines which are so conspicuous on the thallus are caused by some of the cortical cells overlapping others towards the margin of the thallus, the overlapping portion having a length of several cells.

The author records an abnormal division of the contents of tetrasporanges of *Dictyota ciliata*, by which they break up into an indefinite number of parts.

Chlorophyll-bands in the Zygote of Spirogyra.‡—According to observations made by Herr V. Chmielevsky on several species of *Spirogyra* and *Rhynchonema*, no coalescence takes place in the zygote (zygosperm) between the chlorophyll-bands of the male and those of the female cell; those of the latter always exhibit a more regular spiral than those of the former. After coalescence has taken place the female band always retains its green colour, while the male band becomes yellow, and gradually breaks up and becomes disorganized, being finally absorbed into the protoplasm of the cell-sap. In lateral conjugation the male band which disappears always lies nearer to the conjugating canal. When the zygote germinates after its period of rest, it always contains only a single nucleus, the result of the coalescence of the nuclei of the male and female cells, and a varying number of chlorophyll-bands, but always the same number as those in the female cell before conjugation, which remain unchanged in the zygote.

Germination of Closterium and Cosmarium.§—Herr H. Klebahn describes the structure and mode of germination of the zygote in species belonging to these two genera of desmids.

In *Closterium* the four chromatophores resulting from the conjugation of the two gametes remain for a time distinct, subsequently uniting into

* Proc. Amer. Acad. Arts and Sci., xxv. (1890) pp. 53–68 (1 pl.). See Bot. Centralbl., xliv. (1890) p. 81.

† Proc. Amer. Acad. Arts and Sci., xxv. (1890) pp. 83–92 (1 pl.). See Bot. Centralbl., 1891, Beih. 1, p. 5. ‡ Bot. Ztg., xlviii. (1890) pp. 773–80 (1 pl.).

§ Jahrb. f. Wiss. Bot. (Pringsheim), xxii. (1890) pp. 415–43 (2 pls.).

two large ones, rich in starch. In the following spring the two nuclei unite, and the contents of the zygote escape from their membrane. Nuclear division then takes its ordinary course, and the zygote divides in two by a constriction in its middle, each half containing a nucleus. Each of these two nuclei again divides into two of unequal size, the larger, which has the character of a resting nucleus, with one or two nucleoles, becoming the nucleus of the new individual, the other, which has the character of a nucleole, disappearing. The germination of the spiny zygote of *Cosmarium* exhibits similar phenomena.

It occasionally happens that three of the four nuclei resulting from the division pass into one of the two new individuals which are the product of germination, the other individual, which contains only one of the smaller nuclei, still undergoing complete development. The author observed also the germination of parthenospores, precisely resembling the zygotes except in their smaller size, each giving birth, like the zygotes, to two new individuals. The chromatic elements of the nuclei of the desmids are not filiform, as in *Spirogyra*, but granular or of the form of short rods, as in *Ascaris*; and Herr Klebahn thinks it probable that in the complete process of impregnation, two fusions take place, one between the two nuclei of the conjugating cells, the other between the large and small nucleus of each cell.

In the germination of other Conjugatæ, species of *Zygnema* and *Spirogyra*, the unicellular product has only a single nucleus, which divides into two when the cell itself divides.

Rhizoclonium.*—Herr S. Stockmayer reduces all the numerous species of *Rhizoclonium* described by various authors to five principal species, *R. hieroglyphicum*, *fontanum*, *Hookeri*, *angulatum*, and *pachydermum*, with numerous sub-species. He classes this genus, *Chætomorpha*, and *Cladophora* together, as forming the family Cladophoraceæ, nearly allied to Ulotrichaceæ. *Rhizoclonium* is distinguished from *Cladophora* by the absence of true branching, from *Chætomorpha* by the presence of rhizoids, though these are wanting in some of the slenderer forms; but it is probable that some of the more slender species of *Chætomorpha* should rather be assigned to *Rhizoclonium*. From *Conferva* and *Microspora*, *Rhizoclonium* differs in its reticulate chromatophores and the plurality of nuclei.

M. F. Gay† regards the presence of rhizoids as the only character which can at present be used to distinguish *Rhizoclonium* from the allied genera *Conferva* and *Cladophora*. He finds the cells to contain one or two nuclei; the zoospores escape through a lateral pore as in *Cladophora*, not by a circumscissile fissure through the middle of the cell as in *Conferva* and *Microspora*.

Oogone and Oosphere of Vaucheria.‡—Herr J. Behrens gives a careful description of the mode of formation of the oogone and oosphere in *Vaucheria sessilis* and *geminata*, confirming, in a general way, the account given by Berthold. The early stage of the formation of the oosphere consists in the detachment of the larger part of the protoplasm

* Abhandl. K. K. Zool.-Bot. Gesell. Wien., xl. (1890) pp. 571–86 (27 figs.).
† Journ. de Bot. (Morot), v. (1891) pp. 53–8 (4 figs.).
‡ Ber. Deutsch. Bot. Gesell., viii. (1890) pp. 314–8.

from the wall of the oogone by vacuolization of the parietal layers. The beak of the oogone becomes perforated by the absorption of the swollen portion of the membrane; and the periplasm then flows out through the opening as a drop of mucilage which may contain a nucleus. In the young oosperm the chlorophyll-bodies become transformed into brown bodies, the process being similar to that which takes place in the antherozoids of the Fucaceæ.

Development of Hydrodictyon.*—According to M. A. Artari, the chromatophore in the cells of *Hydrodictyon utriculatum* is not granular, but forms a perforated and deeply lobed parietal plate, which becomes eventually very thin and reticulate. The mature cell is multinucleated, and the "light patches" are the nuclei seen through the chromatophore. Each nucleus subsequently forms a part of a megazoospore, these being formed by the breaking up of the chromatophore, and finally acquiring their vibratile cilia; each megaspore at this time contains a pyrenoid. The microzoospores (gametes) are formed in the same way as the megazoospores, the only difference being in their relative size and number.

Fungi.

Histology of Fungi.†—M. P. A. Dangeard has investigated the minute structure of Fungi belonging to the following families, especially with regard to the occurrence and number of nuclei:—Synchytriaceæ, Olpidiaceæ, Chytridineæ, Ancylisteæ, Saprolegniaceæ, and Peronosporaceæ; also *Spumaria* among Myxomycetes. A new genus *Resticularia* is described, belonging to the Ancylisteæ, nearly allied to *Lagenidium* and *Myzocytium; R. nodosa* is endophytic in *Lyngbya æstuarii*. The following are some of the more important conclusions arrived at.

The nuclei are most often limited by a double achromatic membrane; in the centre is a spherical nucleole which stains strongly with hæmatoxylin, being composed almost entirely of chromatin. Between the membrane and the nucleole is a more or less dense hyaloplasm, inclosing granulations, some at least of which consist of chromatin. The size of the nucleus varies greatly, the most frequent being between 1 and 5 μ; in *Synchytrium* it is much larger. In the young sporanges, cysts, spores, and zoospores, each cell contains a single nucleus; at a later period, especially in the vegetative cells, the number is often very large. The structure of the nucleus is subject to certain variations. The nucleole may be very minute or altogether wanting, when the nucleus is reduced to a simple vesicle with aqueous contents; the hyaloplasm may be destitute of granulations.

The mature sporanges and conids contain a definite number of nuclei, the number of zoospores being the same as that of nuclei, while each spore may contain several nuclei. The cysts are uninucleated.

The nucleation of the oosphere varies greatly in the different families. In *Ancylistes Closterii* the oosphere has, at all its stages, several nuclei, and the antherid is also plurinucleated. In *Saprolegnia Thuretii* the oogone includes a large number of nuclei; but these become

* Bull. Soc. Imp. Nat. Moscou, 1890, pp. 269–87 (1 pl.).
† Le Botaniste (Dangeard), ii. (1890) pp. 63–149 (2 pls.).

subsequently indistinct, and the young oospheres contain scarcely a trace of nucleus. In *S. monoica* the antherids possess several nuclei. In *Aphanomyces*, the number of nuclei in the oogone is about fifteen, in the antherids from three to six. In *Pythium*, the number in the oogone is from five to fifteen, according to the species, and it is possible to follow them out until the formation of the oospheres. In *Cystopus* the oogone has a large number of small nuclei; in *Plasmopora densa* both oogones and antherids are plurinucleated. As a general rule it may be said that both oogones and antherids contain several nuclei; those of the oogone may be divided into two groups; some of them are located in the periplasm, and are utilized in the formation of the spore-membranes; others remain in the oosphere; at the moment of fecundation they become indistinct, or only two of them are visible towards the centre; subsequently a large number are formed, which furnish, by division, the nuclei of the zoospores and of the vegetative filaments. A similar process appears to take place in the antherids.

Action of Fungi on copper and bronze.*—M. R. Dubois finds that concentrated solutions of cupric sulphate, neutralized by ammonia, as employed for the immersion of gelatinized plates used in photogravure, frequently contain whitish flocks of a septated fungus-mycele closely resembling that of *Penicillium* or *Aspergillus*. If a solution of cupric sulphate containing this mycele is placed on a carefully washed bronze coin, it will, when the liquid is completely evaporated, be covered by green spots resulting from the power of the fungus-mycele to convert the cupric sulphate into carbonate.

Effect of corrosive sublimate on Fungi.†—According to Mr. H. W. Russell glycerin containing 1 part in 10,000 of mercuric chloride does not interfere with the growth of *Penicillium glaucum*, while a proportion of 1 part in 6000 or 1 in 4500 entirely stops it. This fungus appears to be somewhat less resistant to the poison than some other forms.

Structure of the Peronosporeæ.‡—M. L. Mangin contests the view that the substance known as fungin or metacellulose exists as a distinct ingredient in the cell-wall of Fungi. The structure of the cell-wall in Fungi is complex, and varies greatly in the different families. In the Peronosporeæ, it consists, in the mycele and oosperms, of two substances, cellulose and callose, which can be separated by the method previously described by the author.§ The callose may occur in the form of spherical masses, or of rings on the inner side of the tube, sometimes almost completely closing its cavity. The mycele of the Peronosporeæ is readily distinguished from that of other families of parasitic Fungi by the presence of these thickenings of callose; the appearance resembles that sometimes presented by pollen-tubes. The mycele of these fungi also puts out small haustoria, of variable form, which furnish excellent characters for distinguishing the species; these also consist partly of callose, which is sometimes present in very large quantities. The constant presence of callose in the mycele of the Peronosporeæ serves as a test for the least trace of these parasites in the plants which they infest.

* Comptes Rendus, cxi. (1890) pp. 655-7.
† Bot. Gazette, xv. (1890) pp. 211-2.
‡ Comptes Rendus, cxi. (1890) pp. 923-6. § Cf. this Journal, 1890, p. 735.

Development of the Sporanges in the Saprolegniaceæ.*—Herr W. Rothert now publishes in German his paper on this subject previously printed in Polish, with an addition relating specially to the more recent papers of Berthold † and Hartog.‡

With regard to the observations of the latter, he points out that the species described by him as *Achlya polyandra* must be a different, hitherto undescribed species, since it has vibratile cilia, while *A. polyandra* is destitute of them. The two different structures of spore occur in the same genus. He also adduces reasons for dissenting from Hartog's view that the escape of the zoospores is due to the chemical stimulus of the oxygen in the medium acting on the motile zoospores.

Thamnidium mucoroides.§ — Herr H. Zukal describes this new species grown on alligator's excrement, which forms an interesting connecting link between *Thamnidium* and *Mucor*. It not unfrequently happens that the contents of the two conjugating cells fail to unite owing to the dividing wall not becoming absorbed. In that case two azygospores are formed.

Bargellinia, a new Genus of Ascomycetes.‖—Prof. A. Borzì describes, under this name, a fungus found in an excoriation of the human ear. Its mycele consists of exceedingly delicate branched and septated hyphæ, some of the branches of which swell at the apex into club-shaped asci, each containing usually a single ascospore, less often two. The author places *Bargellinia* among the Exoascaceæ, in the neighbourhood of *Endomyces*, *Eremascus*, and *Eremothecium*, but most nearly allied to *Oleina* and *Podocapsa*.

Semi-lichens.¶—Under the name "Halbflechten," Herr H. Zukal describes a number of organisms coming under one or the other of the following denominations:—Forms ordinarily occurring as lichens with their proper algæ, but in which the alga is sometimes wanting, and which therefore carry on a saprophytic existence; fungi which as a rule exist as saprophytes or parasites, but occasionally combine with an alga into a lichen-thallus; forms which generally occur united to particular algæ, but in their general behaviour resemble a parasite rather than a lichen-forming fungus. The following examples are given:—

Paruphädria Heimerlii g. et sp. n., on the stem and leaves of *Jungermannia quinquedentata*. The following is the diagnosis of the new genus:—Fructification blackish or dark brown, horny when dry, when moist cartilaginous and mucilaginous, inclosed when young by a flat cover perforated in the middle, which afterwards assumes the form of a ring or collar.

Glœopeziza Rehmii g. et sp. n., epiphytic on *Jungermannia trichophylla*. The genus is characterized by an almost microscopic fertile disc, bounded on the side by an envelope composed of modified para-

* Beitr. z. Biol. d. Pflanzen (Cohn), v. (1890) pp. 291–349. Cf. this Journal, 1888, p. 271.

† Cf this Journal, 1887, p. 420. ‡ Cf. this Journal, 1890, p. 807.

§ Abhandl. K. K. Zool.-Bot. Gesell. Wien, xl. (1890) pp. 587–90 (1 pl.).

‖ Malpighia, ii. 1888 (1890) pp. 469–76.

¶ Flora, lxxiv. (1891) pp. 92–107 (1 pl.); and SB. K. K. Zool.-Bot. Gesell. Wien, xl. (1890) p. 53.

physes, above by a dome-shaped gelatinous mass. There is no pseudo-parenchymatous cortex. Otherwise it resembles *Ascophanus*.

Nectria phycophila sp. n. (*Hypheothrix Zenkeri* Ktz.); *Endomyces Scytonematum* sp. n. (*Ephebella Hegetschweileri* Ktz.).

There is in fact no sharp demarcation between ordinary fungi and those which form lichens.

Calcareous Lichens.*—From an examination of exceedingly thin sections of *Verrucaria calciseda*, Herr E. Bachmann has satisfied himself that, contrary to the view of Zukal, the lime is not a product of excretion of the hyphæ of the lichen; but that both the hyphæ and the gonids are imbedded in hollows in the calcareous crystals, the principal part of the thallus penetrating the calcareous substratum to a depth of several millimetres. Similar results were obtained with other calcareous lichens.

Reserve-Receptacles in Lichens.†—Herr J. M. Hulth describes several examples of the occurrence of the reserve-receptacles in calcareous lichens, termed by Zukal "spheroid-cells." They contain a fatty oil; and that this is used up in the further development of the lichen is shown by the fact that the cells in question are frequently found empty.

Myriangium ‡—Dr. A. Minks has investigated the structure of this genus, which was erected by Nylander into an independent family of Lichens of primary importance, but has generally been placed under the Collemacei. Dr. Minks regards it as coming under his class of Pseudo-Ascomycetes. The ascus closely resembles that of *Arthonia*.

Pathogenic Species of Taphrina.§—Herr R. Sadebeck enumerates thirty-five species of *Taphrina*, five of them new, which cause injury to the plants on which they grow, these being almost invariably woody plants. Under the genus *Taphrina* (the older *Exoascus*), Sadebeck includes all those parasitic Ascomycetes in which the asci are not united into a fructification, but are distinct, often in great numbers, densely covering the leaves or flowers, and originating from a mycele which penetrates between the cells or beneath the cuticle of the tissue of the part attacked, but never piercing the cells themselves.

Distribution of Saccharomyces apiculatus.‖—From a fresh series of experiments, the details of which are given in full, Herr E. C. Hansen confirms his previous conclusions that this well-defined form of *Saccharomyces* propagates itself chiefly on ripe and succulent fruits, and not in the nectaries of flowers nor in the excrements of animals. The cells can retain their vitality in the soil for a period of at least three years.

The author expresses the opinion that the cycle of *S. apiculatus* may be taken as typical for most of the *Saccharomyces*. Pasteur, however,

* Ber. Deutsch. Bot. Gesell., viii. (1890) pp. 141-4 (1 pl.).

† Naturv. Studentsällsk. Upsala, March 7, 1889. See Bot. Centralbl., xlv. (1891) pp. 209 and 269.

‡ Ber. Deutsch. Bot. Gesell., viii. (1890) pp. 243-50.

§ Arbeit. Bot. Mus. Hamburg, 1890, 37 pp. and 5 pls. See Bot. Centralbl., 1891, Beih. 1, p. 75. Cf. this Journal, 1889, p. 680.

‖ Ann. Sci. Nat. (Bot.), xi. (1890) pp. 185-92. Cf. this Journal, 1882, p. 234.

considers that wine-yeasts pursue a different course, on the assumption that these cells are unable to retain their vitality in the earth from season to season.

Life-history of Puccinia Geranii sylvatici.*— Dr. A. Barclay has followed out the life-history of the Himalayan variety of this fungus, parasitic on *Geranium Nepalense*. Its cycle of development is complete without the formation of any other kind of spore than the teleutospores, of which it produces two distinct crops in the spring and summer. It is further interesting in partaking of the characters both of a *Leptopuccinia* and of a *Micropuccinia*, and thus breaking down the distinction between these two divisions of the genus.

Frankia subtilis.†—Herr H. Moeller supports Brunchorst's view that the swellings on the roots of the alder and of the Elæagnaceæ are true galls, and that they are produced not by a *Plasmodiophora*, but by a true fungus, *Frankia subtilis*. This has now been determined by Moeller to be a unicellular or pluricellular fungus belonging to the Hyphomycetes, producing a mycele of which each branch ends in a sporange; the protoplasm of this sporange divides into a large number of spores, each of which puts out a germinating filament, which gives birth to a new mycele. The galls are induced by the parasitism of this fungus.

Podaxon.‡—M. N. Patouillard gives a monograph of the eleven species of this exotic genus of Fungi, two of them new. They resemble the stalked *Lycoperdons*, and are composed of a tissue consisting of slender septated hyphæ, variously branched and anastomosing, and containing lacunæ. The basids are usually collected into large tufts on the trama, and the spores are, in most of the species, sessile.

Spores on the Surface of the Pileus of Polyporeæ.§ — M. N. Patouillard records the occurrence of this phenomenon in *Polyporus fulvus* and *nigricans*. The spores are borne at the extremity of basids, which differ only in their position from those of the tubes. He regards the upper surface of the pileus as altogether homologous with the inner surface of the tubes, and as being equally entitled to the designation of hymenium.

Mycetozoa.

Orcadella, a new Genus of Myxomycetes.‖—Under the name *Orcadella operculata*, Mr. H. Wingate describes a new species and genus of Myxomycetes, found on living stems of *Quercus rubra* in the United States. He founds on it a new family of ORCADELLACEÆ, characterized by having sporanges without columel or capitulum, the upper part of the thick septum of the sporange being replaced by a delicate membrane with finely marked margin.

* Ann. of Bot., v. (1890) pp. 27–36 (1 pl.).

† Ber. Deutsch. Bot. Gesell., viii. (1890) pp. 215–24 (1 fig.). Cf. this Journal, 1887, p. 611.

‡ Bull. Soc. Mycol. France, vi. (1890) pp. 159–67 (1 pl.). See Morot's Journ. de Bot., v. (1891) Bull. Bibl., p. xviii.

§ Soc. Mycol. de France, v. (1889). See Bot. Centralbl., xliv. (1890) p. 250.

‖ Rev. Mycol., xii. (1890) pp. 74–5.

Protophyta.

a. Schizophyceæ.

Symbiosis of Algæ and Animals.*—Prof. A. Famintzin describes the symbiosis of *Tintinnus inquilinus* with a diatom belonging to the genus *Chætoceras*, previously erroneously described as an *Ectocarpus*. The structures described as "yellow cells" he divides into two classes, one formed by *Zooxanthella extracapsularis*, the other by *Z. intracapsularis*. He has studied the vegetable parasite on species of the genera *Collozoum* and *Sphærozoum*.

Aquatic Vegetation in the Dark.†—Herr H. de Vries has investigated the fauna and flora of the dark places in the water supply system of Rotterdam. He finds the latter to consist almost entirely of enormous brown masses of *Crenothrix Künthiana*, together with a few desmids and diatoms. These were accompanied by large quantities of fresh-water sponges, and of *Dreyssena polymorpha* and *Cordylophora lacustris*.

Dicranochæte.‡—Dr. G. Hieronymus describes in further detail this genus of Protococcaceæ, distinguished by each cell putting out one, or less often, from two to four hyaline bristles, from 80 to 160 μ in length, composed of gelatin. The bristles pierce the gelatinous envelope of the cell, which is often conspicuously striated in a radial direction when stained, and are usually branched. The contents of each cell divide ultimately into from eight to twenty-four zoospores, which escape by the lifting up of a portion of the cell-membrane as a kind of lid which is furnished with spiny protuberances. The chlorophore contains one or more pyrenoids, as well as starch-grains. Each zoospore contains a nucleus.

Coscinodisceæ.§—With the view of checking the undue multiplication of the genera and species of diatoms, Dr. J. D. Cox has studied the various forms of Coscinodisceæ, and proposes the following seven types, round which several hundred alleged species range themselves, viz.:—*Actinocyclus Ehrenbergii*, *Coscinodiscus subtilis*, *C. radiolatus*, *C. lineatus*, *C. radiatus*, *C. centralis*, and *C. marginatus*. The characters of these seven types are given, and the following observations added:—(1) The so-called pseudo-nodule of *Actinocyclus* is less important as a generic mark than the other characteristics which are identical with the fasciculate *Coscinodisci*. (2) Colour is an untrustworthy mark of species. (3) The number of fascicles is no mark of species. (4) The so-called subulate spaces in *Actinocyclus* are not marks of distinction of species. (5) Considerable changes of form may occur without becoming the ground of new species. (6) Sparseness of alveoli is often misleading as to pattern of marking, and is not reliable as a specific distinction. (7) A striated margin is often apparently present or absent, as more or less of the bevelled marginal zone of the fasciculate forms is shown. (8) New species have often been based upon different valves of the

* Mém. Acad. Sci. St. Pétersbourg, 1890. See Neptunia, i. (1891) p. 33.

† 'Die Pflanzen u. Thiere in d. dünklen Räumen d. Rotterdamer Wasserleitung,' Jena, 1890, 8vo, 73 pp. and 1 pl.. See Bot. Centralbl., xlv. (1891) p. 46.

‡ Beitr. z. Biol. d. Pflanzen (Cohn), v. (1890) pp. 351–72 (2 pls.). Cf. this Journal, 1889, p. 101.

§ Proc. Amer. Soc. Micr., 1890, pp. 184–204 (2 pls.).

same frustule. (9) Marginal or intra-marginal circlets of spines are a very variable character. (10) The rosette in the centre of *C. radiatus*, &c., is not a mark of species. (11) *Craspedodiscus* is not generically or specifically distinct from *Coscinodiscus*. (12) The occurrence of two thin places in the rim of *Coscinodiscus* is not a mark of species. (13) Confluence of alveoli into larger ones is not a mark of generic difference. Much further knowledge is required of the life-history of diatoms before we can lay down final laws as to the limitation of genera and species.

New Genera of Diatoms.—M. P. T. Cleve* describes a new genus of Diatomaceæ, *Dictyoneis*, including several new species, and others previously included under *Navicula*, *Pseudodiploneis*, and *Mastogloia*, in which the outer layer of the valve is composed of large areolations, having the form of vesicles, and giving to this layer a reticulated appearance. It is exclusively marine, and from the warmer parts of the globe; fossil forms are also known.

Brunia is a new fossil genus from Japan, described by M. M. J. Tempère,† in which the valve has the form of a round plate, the hollow of which is moderately deep, and has its walls at right angles to the bottom; the edge is beautifully sculptured.

Diatoms from Java.‡—Among a collection of freshwater diatoms from Java, Herr O. Müller describes one in both the fresh and fossil condition, which must have persisted unchanged since the Middle Tertiaries, *Melosira undulata*. It is remarkable from the fact that many individuals have more than one stalk; and apparently any spot in the cell-wall can give rise to a stalk which connects itself with any spot in a neighbouring cell. The stalk appears to be a product of transformation of the outermost layer of the cell-wall. The author also had under his observation a fragment of a fossil auxospore, and was able to determine that the mode of formation of auxospores was the same in those remote times as to-day.

Pearls of Pleurosigma angulatum.§—Regarding the controversy whether the so-called "pearls" of this diatom are round or hexagonal, M. L. Duchesne states that it is shown by photomicrometrical observation that their apparent form is simply a question of focusing. If the objective is focused exactly to the summits of the pearls, they appear round, if to their base or lower, a hexagonal image is obtained. The author's own observations lead him to the conclusion that their true shape is round.

Commenting on this paper, Dr. J. Pelletan || maintains, contrary to the view of Van Heurck, that the "pearls" are not hexagonal and hollow, but are really, as their name implies, hemispherical projecting grains, which may possibly become hexagonal at their base owing to reciprocal pressure. When the focal plane was tangent to the pearls, each pearl was represented by a black spot (the top which was in focus) surrounded by a white circle (the rest of the pearl which was not in focus). As the focal plane was lowered, each pearl gave a larger and

* Le Diatomiste, i. (1890) pp. 14–7.
† T. c., pp. 21–2 (1 pl.).
‡ Ber. Deutsch. Bot. Gesell., viii. (1890) pp. 318–31 (1 pl.).
§ Le Diatomiste, i. (1890) pp. 27–30 (2 pls.).
|| Journ. de Micrographie, v. (1891) p. 356.

larger black circular image, surrounded by a smaller and smaller white circle, until at length an image was obtained in the thickness of the valve where the pearls take their origin. The image was then hexagonal.

Deformed Diatoms.*—Dr. J. D. Cox describes a number of specimens of diatoms which are deformed in the following ways, viz.:—(1) indented or deformed outlines; (2) double or multiple centre in the scheme of marking; (3) marking unsymmetrically varied. He thinks that a further study of this subject may have the effect of reducing the enormous catalogue of species of diatoms.

β. Schizomycetes.

Bacteria and Disease.†—In a lecture on the connection between bacteria and the poisons of disease, Prof. Brieger, after alluding to the early historical aspects of the subject, takes as his keynote the aphorism invented by Mitscherlich, that Life is but Putrefaction. He then passes on to consider the alkaloidal bases met with in the human body. The aromatic series, such as indol, skatol, carbolic acid, kresol, are passed over rapidly, as being of little import. He then divides the products of bacterial metabolism into toxines and ptomaines, according as they are poisonous or non-poisonous. He then proceeds to show how closely connected these bodies are with the presence of bacteria and the process of digestion; for example, when fibrin is digested with pepsin, a poison, peptotoxin, is produced which kills the lower animals with palsy of the posterior extremities. So too from decomposing flesh can be isolated neuridin, cadaverin, putrescin, and certain toxines, as neurin, methylguanidin, mydatoxin, and a fourth isomerous with typhotoxin. Another toxine, alluded to at some length on account of its fatality and special character, is mytilotoxin, a poison found in mussels.

The author next proceeds to notice these ptomaines and toxines which are the direct derivatives of pathogenic bacteria. The first alluded to are *Staphylococcus pyogenes aureus* and *Streptococcus pyogenes*. These micro-organisms, which are intimately connected with pyæmia and septicæmia, show, however, important chemical differences; for the former when cultivated in meat broth throws off ammonia, and the latter trimethylamin.

The bacillus of typhoid is responsible for typhotoxin, and the cholera bacillus for several, such as penta- and tetramethylendiamin, methylguanidin, and certain specific toxines. Passing over the toxines of tetanus and anthrax, we may notice that four authors are quoted who have found that that curious disease cystinuria is due to an intestinal mycosis, and must therefore be placed among infectious diseases.

The specific action of the various toxines is regarded as a conclusive proof of the constancy of the species of bacteria.

Infection of Vicia Faba by Bacillus radicicola.‡—By an apparatus contrived for the purpose, Herr M. W. Beyerinck has been able to infect plants of *Vicia Faba* by *Bacillus radicicola*, and thus to induce the formation of the well-known tubercles on the root. He finds these bacilli to

* Proc. Amer. Soc. Micr., 1890, pp. 178–83 (1 pl.).
† Biol. Centralbl., x. (1890) pp. 364–73.
‡ Bot. Ztg., xlviii. (1890) pp. 837–43 (1 fig.).

be an extraordinarily delicate reagent for nitrogenous compounds, forming albuminoids out of them. The author regards *Bacillus Ornithopi*, which produces tubercles in the roots of *Ornithopus sativus* and *perpusillus*, as a different species from *B. radicicola*, the latter not causing the production of tubercles in species of *Ornithopus;* while the latter is without effect on *Vicia Faba.*

Micro-organisms of Influenza.*—Herr Bein examined twenty cases of influenza for the purpose of ascertaining if the disease were causally connected with one or various micro-organisms. In the sputum, in pleural exudation, in the lungs, and in the dead body, diplococci, streptococci, and staphylococci were invariably present, and the conclusion arrived at is that the lung mischief in influenza is due to the co-operation of several kinds of micro-organisms, no specific microbe being detected. The author regards the diplococci alluded to as being closely allied to, but not identical with, Fraenkel's diplococcus. Micro-organisms were never found in the blood of patients while alive.

Sig. S. Sirena † found in the sputum of influenza Fraenkel's diplococcus, together with numerous other micro-organisms. In a case of hæmorrhagic pneumonia this microbe was present in the sputum as an almost pure cultivation. Moreover, gelatin-plate cultivations of the nasal secretion failed to demonstrate any other micro-organism. Special attention was paid to the examination of the blood. In the fresh condition both stained and unstained preparations failed to show micro-organisms or other abnormal constituents, so too cultivations on various media remained without exception sterile. The author concludes, therefore, that the presence of certain microbes in the sputum and other secretions in cases of influenza is connected with the simultaneous or consecutive complications of this disease, and that its specific contagium is at present unknown.

Influence of Ozone on the Growth of Bacteria.‡—From an examination of the influence of ozone on the growth of bacteria, Herr Wyssokowicz finds that the bacteria examined by him (anthrax, typhoid, pneumonia, mouse-septicæmia) have their growth decidedly interfered with by ozone. With chromogenic bacteria the pigment development was either nil, much diminished, or tardy; a condition which apparently depends directly on the action of the ozone on the pigment. Spore-formation also was tardy and scanty. The action of ozone is the result of a diminution of the nutrient value of the medium, owing to the oxidation of the bases in the medium. The influence of oxygen depends not only on the formation of acids, but also on other changes, which have previously occurred in the nutrient medium.

Action of Pyoctanin on Bacteria.§ — The experiments of Herr Jaenicke, with *Pyoctanium cæruleum*, *P. aureum*, and methyl-violet 6 B,

* Zeitschr. f. Klin. Medicin, xvii. (1890) No. 6. See Centralbl. f. Bakteriol. u. Parasitenk., ix. (1891) pp. 171–2.

† La Riforma Med., vi. (1890) p. 680. See Centralbl. f. Bakteriol. u. Parasitenk., ix. (1891) pp. 174–5.

‡ Mittheil. Wiss. Brehmer's Heilanstalt, 1890. See Centralbl. f. Bakteriol. u. Parasitenk., viii. (1890) p. 662.

§ Fortschr. d. Med., viii. (1890) No. 12. See Centralbl. f. Bakteriol. u. Parasitenk., viii. (1890) pp. 598–9.

are practically a repetition of those previously made by Stilling, who found that certain anilin pigments possessed an inhibitory (and even disinfecting) action on the growth and development of bacteria. The author used as media meat-extract-peptone-grape-sugar-bouillon, and blood-serum; these were mixed with definite quantities of the pigments, inoculated with certain micro-organisms, and incubated for ten days at 36° C.

In the result it was found that the methyl-violet was more efficacious than the auramin, and might be used for practical purposes as a 1 per thousand solution. In the face of its toxic action and the by no means inconsiderable local irritation, the advantages are doubtful, although of course the observations are not without value.

Action of Artificial Gastric Juice on Pathogenic Micro-organisms.*—Herr G. Kabrhel, in examining the action of artificial gastric juice on typhoid bacillus, cholera bacillus, *Bacillus neapolitanus*, *B. diphtheriæ* Emmerich, *Staphylococcus pyogenes aureus*, and *Streptococcus articulorum*, adopted three modifications by combining an aqueous solution of pepsin plus hydrochloric acid, an aqueous solution of the acid alone, and an aqueous solution of pepsin to which hydrochloric acid and albumen were added.

It was found that the acid without or with pepsin had a powerful antibacterial action, especially on typhoid and cholera bacilli, to which micro-organisms special attention was devoted.

The question next arose as to the effect on micro-organisms which the gastric juice, or say the acid only, would have under approximately normal conditions; for in the stomach the acid compounds of albumen are formed, and this is hardly the same thing. And in fact the author's experiments showed that in the presence of albuminous bodies the hydrochloric acid lost its antiseptic action, at least to a considerable extent, for the cholera bacillus was the only microbe experimented on under the conditions alluded to, that is with hydrochloric acid and albumen, which did not survive.

Ripening of Cheese.†—Herr L. Adametz ascertained, by bacteriological examination of two kinds of cheese (Emmenthaler and Hauskäse), that these reeked with micro-organisms, Emmenthaler containing 850,000, and Hauskäse 5½ millions per gram.

That the presence of bacteria in cheese was certain follows from the fact that disinfectants stop the ripening process, as also does sulphuric acid vapour when new cheese is kept in it.

Nineteen species of bacteria were isolated from cheese. Of these, seventeen were new species, five belonging to the genus *Micrococcus*, four to the genus *Sarcina*, and eight to the genus *Bacillus*. From their physiological properties these bacteria are divisible into three groups:—(1) Those which being able to dissolve the paracasein or to convert it into a softened condition, give rise to a greater or less quantity of albuminoids or peptone, frequently accompanied by traces of disagreeable (butyric

* Archiv f. Hygiene, x. (1890) No. 3. See Centralbl. f. Bakteriol. u. Parasitenk., viii. (1890) pp. 282–3.

† Landwirthsch. Jahrb., 1889, pp. 227–69 (2 pls.). See Bot. Centralbl., xliii. (1890) p. 26.

acid) and agreeable (extractive matter) compounds. (2) Those which develope with difficulty in sterilized milk, and for which unaltered paracasein is a favourable nutrient medium. (3) Those which have no special effect on the nutrient material, and the presence or absence of which has, in contradistinction to classes 1 and 2, no bearing on the ripening process.

Pseudo-tuberculosis of Rodents.*—Herr Pfeiffer proceeded to examine this question by inoculating two guinea-pigs with pieces from the lungs and lymphatic glands of a horse affected with glanders. In about eight days the animals died, and on examination their various organs were found to be infiltrated with nodules (pseudo-tubercles). From the spleen and liver cultivations were made, and in 18 to 20 hours colonies of plump bacilli developed. These, although in certain respects resembling the bacilli of glanders, were not identical with them. From scores of infection experiments the author found that this bacillus was only inoculable on rodents. The cultivated bacillus did not stain with Gram's method and Bismarck-brown, only imperfectly with methyl or gentian-violet, somewhat better with fuchsin, but best of all with Loeffler's methylen-blue solution. With the exception of potato, the bacillus grew on all the usual cultivation media, and at high and low temperatures.

Spore-formation was not observed. The virulence of the organism was not affected by exposing it for hours to subnormal temperatures ($-$ 16° C.), but $+$ 60° C. destroyed it in one hour.

Present Position of the Theory of Immunity.†—In discussing the various views on immunity, Herr Ribbert divides them into two categories according as they deal with absolute or relative immunity. Absolute immunity embraces all the theories which do not require any active exertion or co-operation on the part of the immune body. To this class belong the hypotheses which assert that the bacteria die from want of nutrition or from some germicidal property of the blood-plasma, a property which is effective from its alkalinity, the presence of CO_2, or to coin a suitable word, its albuminism. According to this view immunity does not depend on a struggle; but relative immunity, which forms the second category, is the result of a contest between the bacteria and the body-elements. This practically amounts to Metschnikoff's theory of phagocytes. The author expresses his views somewhat as follows. Absolute immunity depends on the inability of bacteria to decompose the albuminoid products of the body in order to apply them for their own nutrition. This may be acquired by the body as the result of a single infection, by supposing that the cells thereby become habitualized to the bacteria, and transmit their acquired resistance to succeeding cell generations and the circulating albumen. Relative immunity depends on the imperfect or insufficient supply of nutrition to the bacteria in consequence of the greater or less resistance of the tissues and juices of the body. The vegetation of the micro-organisms causes an increased development of heat, and an augmented accumula-

* Leipzig, 1889, 6 microphotographs. See Zeitschr. f. Wiss. Mikr., vii. (1890) pp. 379–80.

† Deutsch. Med. Wochenschr., 1890, No. 31. See Centralbl. f. Bakteriol u. Parasitenk., viii. (1890) pp. 734–6.

tion of the germicidal products of tissue change. The increased metabolism is the result of heightened activity of the cells in the protoplasm of which the bacteria are most easily destroyed. In local diseases the leucocytes co-operate in the destruction of the bacteria by surrounding them, and thus preventing their entrance into the lymph-streams.

Antiseptic Action of the Fluoride of Methylen on the Pyogenic Bacteria of Urine.*—M. O. Chabrié made the following experiments to ascertain if the gas discovered by him, fluoride of methylen, possessed an inhibitive action on the development of the pyogenic bacteria found in the urine. Two test-tubes containing urine infected with pyogenic bacteria were inverted under mercury; one of the tubes contained equal volumes of air and the fluoride of methylen, the other air alone. After having been kept for 24 hours at a temperature of 35°, a drop was taken from each specimen and inoculated in sterilized bouillon. The two bouillon flasks were then incubated for 24 and 48 hours respectively. At the end of that time it was found that there was no development in the flask infected from the urine treated with the antiseptic gas, but in the other a copious development.

A similar experiment was carried out, but this time the mercury was omitted; the same result was obtained. Hence the author concluded that this gas might be used for treating certain cases of inflammation of the bladder, provided that its action were not too irritating. To ascertain this, a mesentery and the web of a frog's foot were exposed to the action of the vapour. No irritating effect was observed other than that produced by the mere passage of air.

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* Comptes Rendus, cxi. (1890) pp. 748–50.

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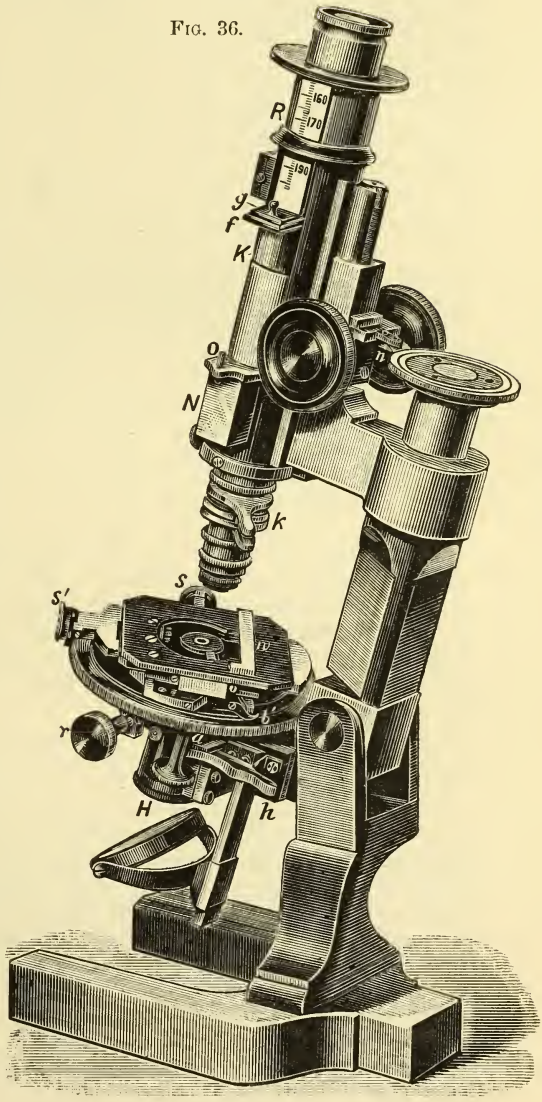
MICROSCOPY.

a. Instruments, Accessories, &c.*

(1) Stands.

Fuess's Petrological and Crystallographic Microscopes.† — Herr R. Fuess has introduced several improvements into his Petrological Microscope, which now has the form given in fig. 36.

Fig. 36.



The object-stage is fitted for fine measurements. The scale is graduated in half degrees and two verniers read to minutes. The stage-plate has a toothed edge and is rotated by means of a pinion *a*, which can be thrown out of gear by the lever *h*. A mechanical stage is applied on the rotating stage-plate. By one of the rectangular movements effected by the screw S an interval of 0·01 mm. can be indicated. The other screw S′ has a more rapid thread to enable the preparation to be quickly passed across the field of view. The mirror slides vertically on an arm which can be rotated to one side. The polarizer has a rack-and-pinion movement. A conical stop fitting into corresponding slots in the socket determines the position of the nicol for 0°, 45°, and 90°. An iris-diaphragm can be inserted beneath the nicol. A condensing lens of great focal length atttached to the polarizer serves for the

* This subdivision contains (1) Stands; (2) Eye-pieces and Objectives; (3) Illuminating and other Apparatus; (4) Photomicrography; (5) Microscopical Optics and Manipulation; (6) Miscellaneous.

† Zeitschr. f. Wiss. Mikr., vii. (1890) pp. 177–87.

illumination of the preparation when the lower objectives are used. This lens forms the lower member of the condensing system, which consists of three lenses, the other two being connected together but detached from the polarizer. The common socket of the two upper lenses is supported in a ring which forms the end of the arm *b* of a rotating plate fitted in the object-stage. By means of a weak spiral spring in the ring-holder, the socket follows the movement of the polarizer, so that the whole condensing system can be adjusted by the pinion which effects the movement of the polarizer. By a second arm *b'* from the rotating plate of the lens-holder, the upper pair of lenses can be moved to one side beneath the mechanical stage, so that the change from convergent to parallel light and *vice versâ* can be rapidly effected without moving the preparation.

The coarse-adjustment of the Microscope is by rack and pinion. The fine-adjustment screw has a pitch of 0·5 mm. The head is divided into 100 parts, and a vernier reads to a fifth of a division, i. e. to 0·001 mm. The end of the body-tube carrying the objective is movable by two fine screws for centering. To facilitate the change of objectives, the latter are not screwed on, but held by the clamp *k*. Immediately above the clamp is a slit for the introduction of a Klein's plate, quarter-wave plate, &c. The analysing nicol N is inserted in a wider opening at the lower end of the body-tube. Another opening K serves for the introduction of the auxiliary objective into the draw-tube R. The lens is fastened in the slide *f*, and forms with the Ramsden eye-piece a complete Microscope, with a magnification of about five times. This constant magnification is advantageous for measuring the apparent optic axial angle. The draw-tube carries a millimetre scale which gives the distance of the eye-piece from the objective. Among the accessories of the Microscope are the illuminating apparatus and spectropolarizer of Abbe, the twin-nicol for stauroscopic measurements, and the illuminating arrangement of Sorby which serves for the observation of the internal and external conical refraction.

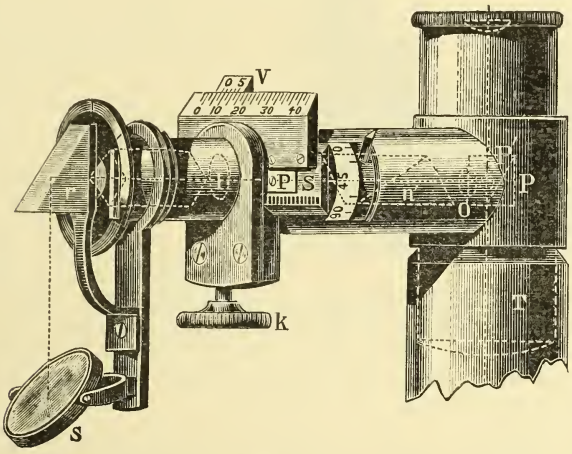
Of the special eye-pieces, the goniometer eye-piece consists of a Ramsden eye-piece which is directed upon cross wires centered by four adjusting screws exactly in the axis of a divided circle.

The quartz-wedge comparator shown in fig. 37 is a modified form of that of Michel Levy. It slides in the tube T of the Microscope, and in this part consists of an ordinary weak eye-piece, in which, in the place of the usual diaphragm, is a double prism of glass P P', with the hypothenuse faces cemented together. The hypothenuse P' is silvered with the exception of a small circle in the centre, through which the polarization tint of the preparation is seen. The main part of the comparator is contained in the side tube. Rays from the mirror *s* are diverted at right angles by the prism *r* into the polarizer *n*, the rotation of which can be measured on a divided circle. The lens *l* concentrates the light upon the quartz wedge *q*, behind which is a diaphragm with a very small aperture. The quartz wedge is fastened in the slide S', which is moved by rack and pinion, and its position is given by the vernier V. The light passes through the analyser *n'* to the lens *o*, and is reflected from the hypothenuse of the prism P' in the direction of the axis of the eye-piece. The polarization tint of the preparation is thus seen

surrounded by that of the quartz wedge, and a ready comparison can be made.

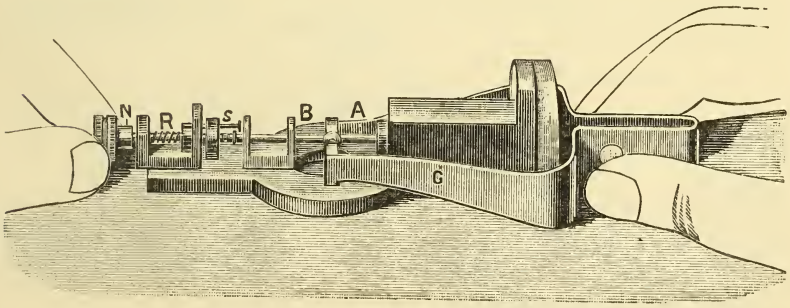
The axial angle apparatus for very small plates, shown in fig. 38, is similar to the Schneider-Adams apparatus, in which two small hemispherical lenses inclosing the plate can be rotated between condenser and

Fig. 37.



objective. The base-plate is held on the stage by spring clips. Above this plate is the horizontal axis, carrying at its outer end a divided circle, with vernier reading to five minutes. The spindle at the other end of the axis A reaches nearly to the middle of the apparatus, and

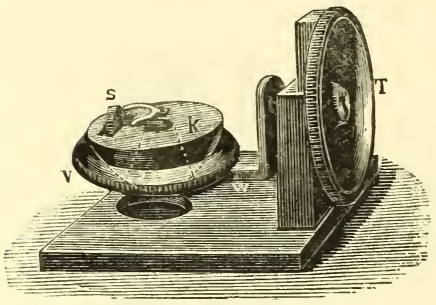
Fig. 38.



is funnel-shaped at its end. The cylindrical bolt B, also funnel-shaped at the end, is movable by the screw R in the direction of the axis. By left-turning of the mother screw N, a spiral spring drives forward the screw shaft, whose end has a funnel-shaped depression in which the end of the bolt fits. By right-turning of the screw the shaft is drawn

back and with it the bolt, by the pin *s* coming in contact with the small projecting plate on the bolt. The two hemispherical lenses are held between the funnel-shaped depressions of bolt and axis. By pressure of the spiral spring the bolt is kept centered with respect to the axis, while it can move freely at both ends so that it rotates with the axis when the latter is turned.

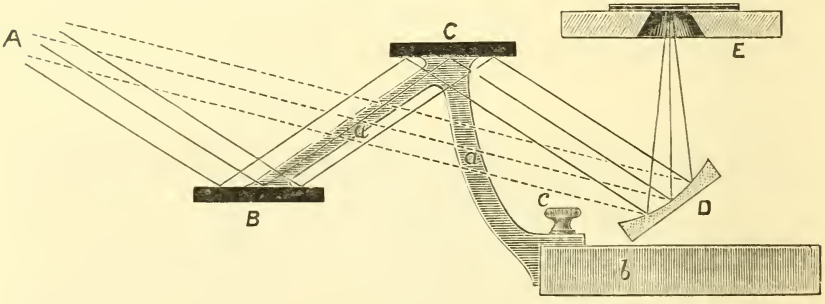
Fig. 39.



The goniometer for microscopic crystals (fig. 39) consists of a base-plate, on which is an upright carrying the divided circle T movable about a horizontal axis. The angle arm *w* ends in a ring which is parallel to the axis of the divided circle, and supports a second ring *v* movable in it. The hemisphere *k*, movable with friction in the ring *v*, has a conical opening bored through it, with the narrow central aperture in the flat surface. Along a radial groove runs the needle, at the point of which the crystal to be measured is fixed. It is kept in position by a spring, and is rotated by the milled head S.

Some Improvements in the Crystallization Microscope.*—Prof. O. Lehmann remarks that the old form of crystallization Microscope, described in Zeitschr. f. Instrumentenk., 1886, p. 325, suffers from the disadvantage that it is impossible to observe the preparation between crossed nicols during the heating. The method which first suggests

Fig. 40.



itself for obviating this difficulty, that of placing the polarizing nicol before the mirror, is unsatisfactory, owing to the large size of the nicol required.

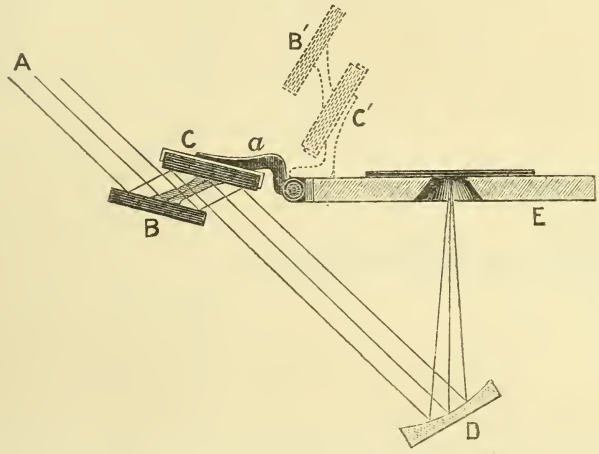
Fig. 40 represents the arrangement proposed by the firm of Zeiss, in which the polarizing nicol is replaced by two piles of glass plates.

* Zeitschr. f. Instrumentenk., x. (1890) pp. 202–7.

Light from the source A, incident at the polarizing angle on the first pile of plates B, is reflected to the second pile C, and thence to the mirror D. The two reflectors are fastened to the frame *a a*, which is firmly fixed to the foot *b* of the instrument by the binding screw *c*. A very slight turn of the mirror is sufficient to direct the unpolarized rays, represented by the punctuated lines in the figure, upon the object, so that the change from ordinary to polarized light and *vice versâ* is very easily effected.

Fig. 41 shows a similar arrangement made at the author's suggestion, by O. Behm, of Karlsruhe. The frame carrying the two reflectors B and

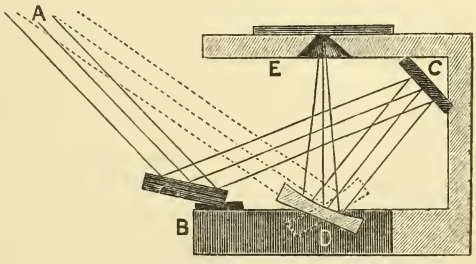
Fig. 41.



C (each consisting of five large cover-glasses) is hinged to the edge of the object-stage E, so that for observation in ordinary light it may be swung back into the position B′ C′.

The arrangement shown in fig. 42, due to Voigt and Hochgesang, of Göttingen, is considered by the author as the most efficient. Rays from the source A fall upon the polarizing reflector B, and thence almost perpendicularly on an ordinary mirror C, from which they are reflected to the concave mirror D. Observation in ordinary light is effected by turning the latter into the position punctuated in the figure.

Fig. 42.



The heating apparatus of the Microscope has been simplified. For ordinary requirements a burner with small non-luminous flame is used

to replace the inconvenient blow-pipe arrangement of the old instrument.

Fig. 43 represents the burner used when only slight changes of temperature are needed. It gives a very small blue flame, and is itself so small as only slightly to interfere with the brightness of the field of view. In the other form of burner (fig. 44), used for higher temperatures, the gas issues from a ring-shaped slit. It is closed beneath by a thin plate of glass or mica, so that the flame is driven towards the centre by the draught thus produced. The brightness of the field of view is not sensibly affected by the passage of the rays through this transparent plate and the thin layer of burning gas within the ring.

Fig. 43.

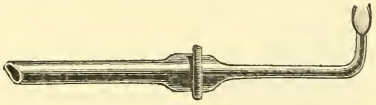
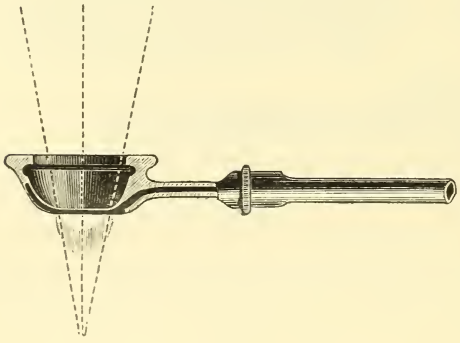


Fig. 44.



As a further improvement of the Microscope, the divided circle is enclosed in the object-stage, so that it is protected from dirt and injury from acid vapours, &c. The scale is read directly from above by means of a window in the upper side of the stage.

For experiments at very high temperatures, the larger instrument described in the Zeitschr. f. Instrumentenk., 1884, p. 369, is necessary. Into this several improvements have been introduced. In order to effect a greater concentration of heat upon the object, and to diminish the heating of the metal parts of the Microscope, the blow-pipe flame is directed through a chimney of asbestos, bound with brass, which can be fitted into the opening of the stage. A new form is given to the water screen protecting the objective. It consists of a socket 2 cm. long, with double walls and strong copper base, which fits tightly over the objective, and expands at its upper edge into a disc of about 5 cm. diameter. To prevent the condensation of water upon the objective, an arrangement is added by which a stream of air is directed upon it.

Improvements have also been made in the Projection Microscope described in this Journal, 1887, p. 291. The indiarubber tubes of the old instrument are replaced by metal ones. For cooling the alum solution, a spiral tube conveying a stream of cold water is used instead of the water screen. The mirror is not rigidly fixed as before, but can be turned about a hinge and fixed by a binding screw several degrees from its normal position of 45°. By this means a uniform brightness can be maintained when, by changes in the electric arc, the illumination of the field of view has slightly shifted. For cooling the

preparation there are three small tubes in the stage, by which a stream of air can be directed upon its under side. Instead of the black cover of the old instrument, two screens are found to be sufficient to prevent the dispersion of the light. One of these is hinged to the holder of the totally reflecting prism, while the other is fixed horizontally above it. The prism is made of a specially strongly refractive glass of the firm of Zeiss, since by the use of ordinary glass a part of the field of view is cut off by total reflection.

Remarking on this paper,* Herr R. Fuess takes exception to the remark, that the old form of instrument, whose construction was undertaken by the firm of Fuess, has the great drawback that it is not possible to observe the preparation between crossed nicols during the heating. To prevent misunderstanding he states that he did actually at one time undertake the construction of the Microscope described in Zeitschr. f. Instrumentenk., 1886, p. 325, but that pressure of business prevented him from attempting any technical improvements in the instrument, and at length compelled him to relinquish the undertaking altogether. He wishes it, therefore, to be clearly understood that no Lehmann Microscope of the form described has been made by him. He adds, that some years ago he constructed a heating apparatus for his crystallographic Microscopes, by which the preparation could be heated to a clear red glow during observation between crossed nicols.

Van Heurck's Microscope for Photography and High-power Work. —The following description of this instrument (fig. 45) is translated, with modifications, from the fourth edition of Dr. Henri Van Heurck's work on 'The Microscope,' which is now in the press:—

"In the Microscope which W. Watson and Sons have made to our specification we have attempted to combine convenience for ordinary work with the utmost possible precision, and at the same time to keep the price comparatively low.

Messrs. Watson have admirably carried out all the plans we submitted to them, and the instrument they have produced may be justly considered as realizing in various ways a degree of perfection which has never hitherto been reached.

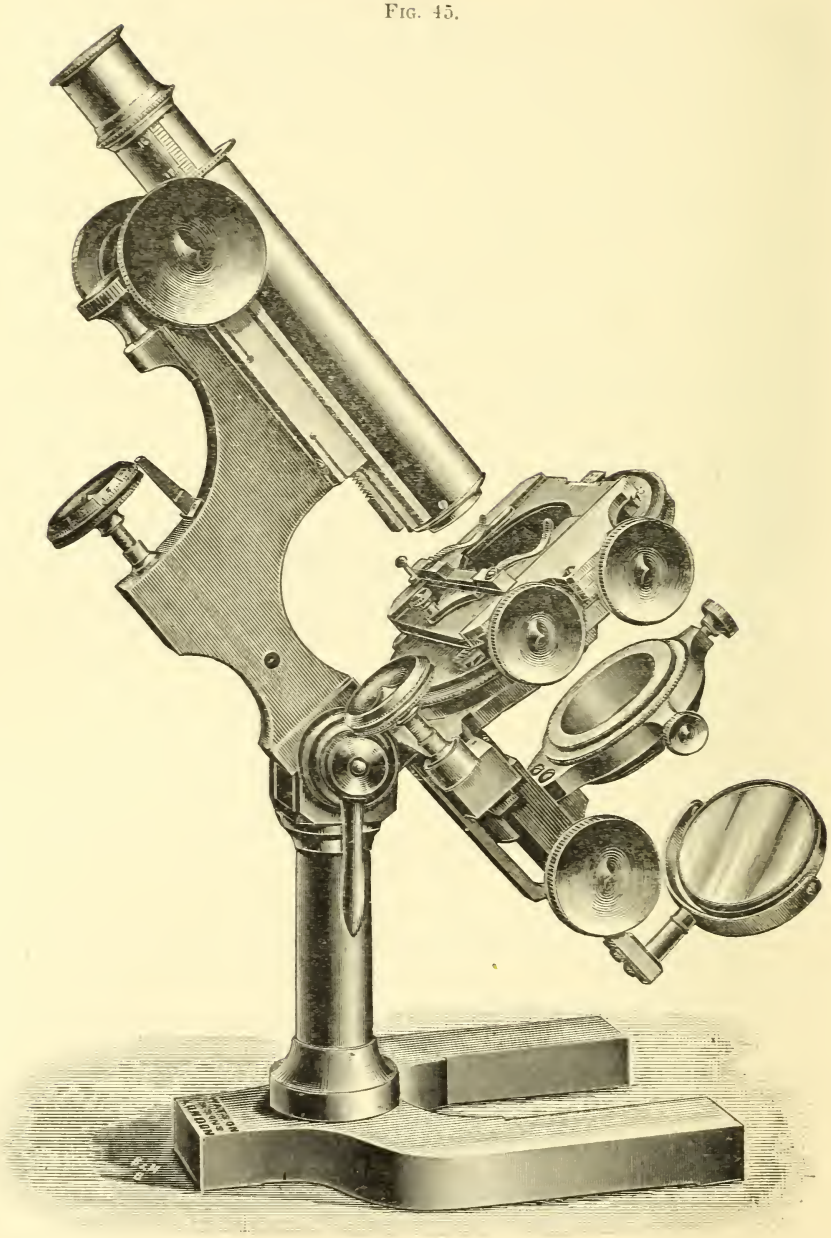
The base of the instrument is of the horseshoe form, bronzed; at the three points on which it stands slightly projecting pieces of cork are inserted, which reduce the tremor, prevent the instrument from slipping, and the table from being scratched.

A substantial brass pillar, jointed in its upper part to allow the inclination of the instrument, supports the Microscope, which can be fixed at any angle by means of a clamping screw, although the instrument is so well balanced as to render this screw almost superfluous.

To increase the general stability, all the parts of the instrument have been made as if they were cast in one piece. The stage-support is made of a single piece, and is prolonged into the articulation of the top of the pillar; the limb fits into the stage-support and is fixed by six screws, so that the whole has the same rigidity as if it formed a single

* Zeitschr. f. Instrumentenk, x. (1890) p. 261.

Fig. 45.



Van Heurck's Microscope for Photography and High-power Work.

piece. Finally, the two pieces fitted together are traversed by the clamping-screw for the inclination.

The stage rotates, and special means are provided to give a very smooth movement, and at the same time to secure perfect firmness in every position without the necessity for any toothed gearing, which seldom works smoothly for any lengthened period. The mechanical movements are effected by two superposed plates, as in the old Ross stands, actuated by lateral screws. The object rests upon a sliding bar provided with a stop-pin and clamping-screw. For ordinary work the sliding bar can be replaced by a fixed plate provided with two ledges. The horizontal and vertical movements have a range of 25 mm., and the divided scales (finders) allow a reading of the movements to 1/10 mm. by means of verniers.

The limb incloses the fine-adjustment and carries the tube in front; both the coarse- and fine-adjustments move in bearings which can be regulated as required. A screw attachment at the upper part of the limb fixes the instrument firmly in the horizontal position when it is required to photograph in that position, though we infinitely prefer photographing with the Microscope in the vertical position.

The fine-adjustment is of exquisite delicacy and of greater precision than that of any other Microscope in our collection. Each turn of the screw of the fine-adjustment corresponds to 1/13 of a millimetre. So perfect is the adjustment, that it is possible in certain cases to estimate to a hundredth of a turn, i. e. to 1/1300 of a millimetre. The mechanism of the fine-adjustment acts in an opposite direction to that of Continental Microscopes, we have therefore marked on the milled head the letters M (*monter*) and D (*descendre*), to indicate the direction in which it is necessary to turn to make the body-tube move up or down.

The body has a draw-tube; when closed up it has a length of 160 mm., which is necessary for the employment of Continental objectives; when drawn out it has a length of 260 mm. and can then be used for the apochromatics for the English tube. The draw-tube is arranged so that it can be blackened internally over part of the space covered by the eye-piece; thus all internal reflection, which is the cause of so much trouble in photomicrography, is absolutely prevented. It might be preferable to line this tube with black velvet. The lower end of the draw-tube is provided with the Society screw for use with the Abbe apertometer.

The mirror is carried by a rod having lateral movement; it can also be slid up or down within a moderate range.

Regarding the substage, which we have designedly reserved to the last, we have to point out some improvements which have not been introduced in any other Microscope. Needless to say, the condenser can be centered, and it can be raised and lowered by rack and pinion; but a fine-adjustment of great delicacy is also applied. In the few Microscopes to which a fine-adjustment of the condenser has hitherto been applied (an adjustment so necessary in certain cases and not yet sufficiently appreciated) this focusing has been simply effected by a screw which does not produce a very slow movement, and there has always been loss of time in the changes of direction. Here, however, the fine-adjustment is actuated by a lever as in the fine-adjustment of the body-tube, *and*

the milled head which actuates the movement is placed above the stage close to the fine-adjustment screw of the body-tube. By this means it is possible to obtain very great precision and to adjust the two movements simultaneously with one hand.

The arrangement of the condenser as planned by us (and employed for several months with all our Microscopes) is, we believe, an important improvement. It consists of an iris-diaphragm surmounted by the lens-holder; between these two pieces slides a plate, removable at will, provided with a central rotating ring which serves for the reception of the diaphragms. The lens-holder is adapted to receive the different Abbe condensers, the Zeiss achromatic condenser, and also adapter plates allowing the use of all the excellent condensers of Powell and Lealand, and may hence be considered of universal application.

To sum up, we have in this instrument combined all the conditions of perfection which long experience in microscopical work has taught us, and Messrs. Watson have realized all our desiderata with a care and precision which we scarcely dared hope for. If we add that this apparatus, so perfect, costs only 400 francs (16*l.*), and consequently less than the large Continental models, it will readily be admitted, we believe, that the makers have rendered a real service to serious workers by its construction."

The Graphological Microscope.* — Mr. C. M. Vorce writes:— "Among the most important of the applications of the Microscope to what are called 'business uses' is the examination of writings, books, &c. The use of the Microscope for such purposes has rapidly increased in the last ten or fifteen years, until now scarcely a case of importance whose turning-point rests on the authenticity of written or printed matter, is tried without the papers or books in question being submitted to Microscopical examination at the hands of experts, real or supposed. Among the points to which such examinations are applied may be mentioned the detection of forgery, alteration, erasure, interpolation, &c., the detection of the authorship of simulated or anonymous writing, the determination of relative age of different writings, identity or difference in inks, pencil marks, paper, &c.; detection of erased writings, the character of stains, marks, mutilations on paper and elsewhere.

Many of the questions involved require very delicate and prolonged examination for their determination, and sometimes the use of high powers, but by far the greater number of questions involve the use of but low or medium powers, and usually the examination of considerable surfaces. Probably every Microscopist who has had occasion to examine writings to any extent has felt the inconvenience of the best modern Microscopes for that purpose, owing to their limited stage room and short rack. In very many cases the examination required involves the comparison of a considerable number of papers, and often of the entire surface of a good sized sheet of paper. The examination of books, such as hotel registers, Bibles, account books, &c., is almost impossible of satisfactory accomplishment with ordinary Microscopes, the only way to proceed being usually to place the instrument on the book and focus through the stage-well. The 'Tank Microscope' of some English

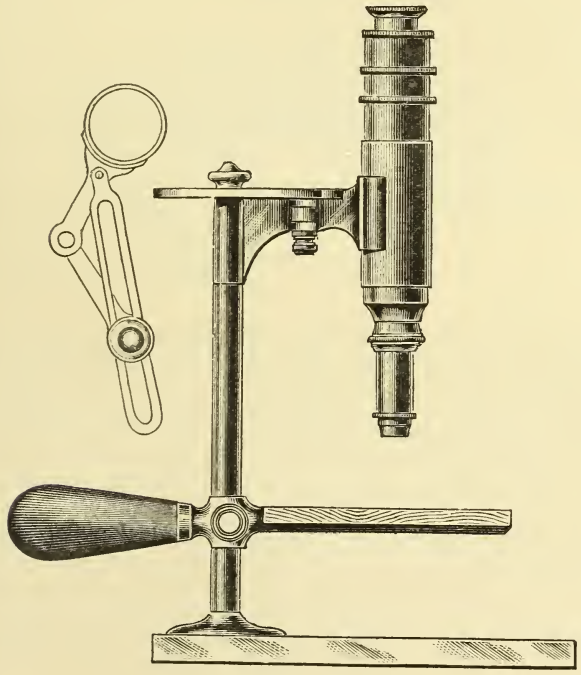
* Microscope, xi. (1891) pp. 47–50.

makers is better for this use than any other present form, but like the others, is objectionable on account of having to be moved about over the book or paper under examination. The danger of marring or obliterating some portions of the writing to be examined often prohibits the placing of the Microscope upon the writing or moving it about, and renders a satisfactory examination quite impossible.

Another serious objection to present forms of Microscope for the uses of the graphologist is the inability to use them as a class Microscope to be passed from hand to hand, with the objects to be viewed securely clamped in position and in focus.

To obviate the defects found in the present Microscopes for such uses and to produce a form adapted to the special needs of the grapho-

Fig. 46.



logist, as made apparent to me by some twenty years of my own experience in that line, and my observation of the work of others, I have devised the Microscope-stand which I have designated The Graphological Microscope, a cut of which is here given, and which is briefly described as follows:—

The pillar is a straight brass rod 5/8 in. in diameter, threaded with a long screw into a plate flush with the surface of the wooden base. The stage is of wood or hard rubber, 5 × 8 in., and rests on a forked brass plate projecting from a stout collar which slides on the pillar, and

is clamped in place by a strong thumb-screw with milled head. From the back of the collar opposite the stage a strong screw projects, upon which a handle may be screwed when the instrument is to be passed about as a class Microscope.

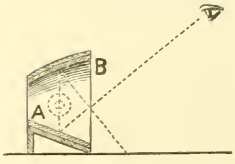
The arm is in two parts joined by a smoothly fitted joint with a nut on the pivot; the outer joint of the arm carries a slip-tube through which the body-tube is focused by sliding, and the inner joint of the arm is extended into a sleeve with a long conical bearing around the top of the pillar, insuring a smooth motion. A flat slotted plate is pivoted to the outer joint of the arm and rests on top of the sleeve of the inner joint, the top of the pillar passing through the slot, being threaded and pivoted with a strong thumb-nut to clamp the arm rigidly in place. By this construction the body-tube may be moved about over every part of a surface 6 in. square, and may be clamped in place over any part of that surface by means of the thumb-nut at the top of the pillar. The paper to be examined can be arranged on the large stage and secured in place by wire clips. In case it is desired to use the instrument as a class Microscope, the arm is clamped fast, the handle screwed on and the pillar unscrewed from the base-plate, when the instrument can be handed about as readily as a common stereoscope, and weighing but little more.

If provision is required for the use of transmitted light, which is but seldom needed, an opening in the stage is provided, and a mirror on the base like that of a dissecting Microscope. An arm for carrying a lamp may also be attached to the pillar by means of a clamping collar like that of the stage-arm, when the instrument is to be used as a class Microscope at night.

It has not been found requisite to provide for inclining the instrument in use, but if desired it can be readily accomplished by providing a slotted segment on the plate into which the pillar screws, hinging this plate to an under plate secured to the base-board, with a clamp screw to clamp the segment against a projection on the fixed plate.

The instrument, as made for me by the Bausch and Lomb Optical Company, has proved very satisfactory in use, and admirably serves the purposes for which it was designed, especially in its capability of being passed from hand to hand. An entirely unpremeditated advantage has also been discovered in the ease with which objects too bulky for examination on ordinary stands, such as large minerals, natural history specimens, &c., can be laid on the base-board (the stage being loosened and swung round out of the way), and examined with this Microscope over all their surface."

Fig. 47.



Magnifying Instrument.*—M. Th. Simon, of Paris, has devised an instrument to replace the ordinary magnifying glass. It possesses the advantage of affording a well-illuminated image. The magnification is obtained by means of a concave mirror B. This is set at such an angle to a second mirror A, that the magnified image is formed in a convenient position

* Zeitschr. f. Instrumentenk., x. (1890) p. 151.

for observation, and the illumination of the body is not interfered with by the instrument.

BERNARD, P.—Note sur un Microscope composé du 18me siècle. Lille, 1890, 8vo.

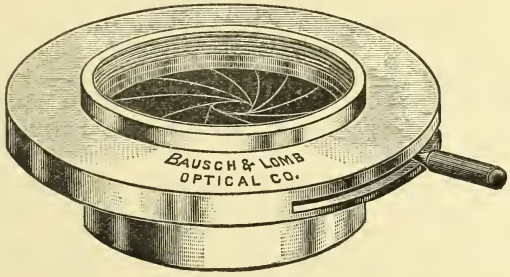
(2) Eye-pieces and Objectives.

JOHNSON, C.—The American Objective as compared with the German. *Maryland Med. Journ.*, XXI. (1889) p. 130.

(3) Illuminating and other Apparatus.

Bausch and Lomb's Condenser Mounting with Iris Diaphragm.—In addition to the form of this device which we figured in this Journal, 1890, p. 508, a simpler and less expensive form has been issued by the firm, as shown in fig. 48.

FIG. 48.



New Lens-holder with Stand.*—M. L. Malassez has constructed a new holder for use with his erecting objectives of long focus. Like the lens-holders in common use, this serves to support ordinary lenses, but will also hold a Microscope-tube provided with the new lenses. It consists of a triangular foot of cast iron and lead, very heavy, giving great stability with considerable space for manipulation. It is covered with india-rubber underneath, to avoid vibration being communicated to the arm of the lens-holder from the table. On this foot is the triangular standard with rack, on which the socket carrying the horizontal arm moves. This arm is not fixed to the socket itself, but to a ring which rotates on it. The result is that the arm can be turned round the standard, without the latter being displaced, so that when, during a dissection for example, it is necessary to dispense for a moment with lens or Microscope, there is no need to move the heavy base, but simply to turn the arm aside. Two fixed stops limit the extent of the rotation, and another stop provided with a spring enables the arm to be replaced in its original position. The friction surface of the ring of the socket is a truncated cone with the base below, an arrangement which prevents the oscillations which with another form of surface would be produced by the wear and tear of the pieces.

The arm of the lens-holder is long, so that, with the arrangement of

* Arch. de Méd. Expér., i. (1889) pp. 455-7 (1 fig.).

the foot above referred to, objects of large size can be examined. Its free extremity receives either a socket for holding the Microscope or pliers for holding the lenses. For this purpose, these pieces are provided with a pin, which fits into the hollow extremity of the arm, and can be fixed in any position required by means of a clamp-screw. By this arrangement the change of the pieces is rendered very easy, and the Microscope-tube can be placed vertically, obliquely, or horizontally. This last position is very useful when objects placed vertically, such as the side of an aquarium, are to be examined. Indices mark the vertical and horizontal positions, and also that at 45°.

The pliers for holding the lens are not, as in other forms of apparatus, in the exact axis of the arm, but at right angles to it. Owing to this arrangement, there is no risk of the nose of the observer coming in contact with the arm, and he is not obliged, in order to avoid this, to turn his head on one side. There are two pliers, the larger for ordinary lenses, the smaller for objectives. One is in front of the arm and the other behind, and they can be placed on either side by turning the pin fixed to the end of the arm.

The rotating ring of the arm has on the opposite side another arm, which is shorter and is terminated by a brass ball filled with lead. It serves to counterbalance the long arm and thus to maintain the stability of the apparatus.

Heating-Lamp with Electric Regulator for controlling the Gas-supply.*—In order to prevent the escape of gas after accidental extinction of the flame in a lamp intended for keeping up a constant temperature, Herren F. and M. Lautenschläger have patented one in which a valve is inserted in the supply pipe, and this valve is kept open by means of an electro-magnet as long as the lamp burns. If this be extinguished, the mercury in the contact thermometer falls until it sinks below a wire melted into the thermometer at a suitable place. As this wire forms part of the path of the electro-magnet, the current is thereby broken, the valve closes, and the gas supply is cut off.

Polarization without a Polarizer.—We cannot congratulate the author of the following note on the originality of the wonderful discovery he has made. Wheatstone and Brewster have unfortunately been before him. We cannot answer for American skies (which no doubt "whip creation" in polarizing as well as in other effects) but in this country at least we fancy that better results would be obtained, when no polarizing nicol was at hand, by the simple expedient of using for mirror a few glass slips inclined at the polarizing angle. Interference figures in crystal sections may often be seen with tolerable clearness when the polarization is produced by simple reflection from the work-table. Mr. H. M. Wilder says:†—"I have accidentally made a quite useful discovery, which I have not seen mentioned before. In order to *polarize*, we put a polarizer (Nicol) beneath the stage, and an analyser (Nicol) above the objective (either right next to it, at the end of the draw-tube, or above the eye-piece). The selenite comes on top of the polarizer. Now I found that the polarizer is not absolutely indis-

* Zeitschr. f. Instrumentenk., xi. (1891) pp. 73-4.
† Cf. Engl. Mech., liii. (1891) p. 113.

pensable. Given a certain polarizing condition of the sky (i. e. blue, with more or less watery vapour—as either before or after a rain, snow, or fog), you can polarize very nicely with the analyser alone, and, if you want display of colour, put the selenite on top of the slide, or anywhere convenient to you—so it comes beneath the analyser. The colours (and crosses) will, of course, be somewhat fainter than when you use the polarizer too. In order to get the best display, it will be necessary to rotate both analyser and selenite until in the proper relative positions; or, to speak more correctly, the relative position of the P.A. of the selenite to the beam of light from the mirror decides the more or less intense coloration. With any other sky, the polarization is not observed. This observation is useful in so far as to enable the possessors of Microscopes, without substage facilities, to polarize fairly well—under the circumstances—and the proper condition of the sky is often obtained in our latitude."

(4) Photomicrography.

Photomicrography.*—Mr. T. Comber writes:—"Photographing with the Microscope, or, as it is now the fashion to call it, "Photomicrography," has always had a great attraction to me. My first attempts at it were made so long ago as 1858, before the days of gelatino-bromide plates, and when the "wet-collodion" process was almost universal.

At that time one of the difficulties to be contended with was the want of coincidence of the actinic with the visual focus of the object-glass. Now most of our English makers can supply objectives specially corrected in this respect, so that when a visual image is focused on the ground glass, an image equally sharp in its actinic effects can be relied upon as thrown upon the sensitive plate. The apochromatics of Zeiss I have always found to be perfect in this respect. I should recommend any of you, who may be desirous of using your Microscope for photography, to be careful to obtain objectives corrected for the purpose; but in case you may be tempted to use an objective that is not so corrected, I may mention the method by which, in those early days, we managed to overcome the difficulty; the more so as the plan constitutes a good test to ascertain whether an objective said to be corrected for photography is in reality correctly corrected. Place a flat object on the stage, for choice a micrometer, and by putting a piece of card under one end of the slide, tilt it slightly up, so that the object no longer lies square to the axis of the Microscope, but is a little nearer on one side, a little further off on the other. Then focus carefully till the division of the micrometer scale lying in the centre of the field gives a sharp image on the ground glass, the other divisions will go gradually out of focus, those on one side being within, those on the other side beyond the focus. Next photograph the scale, and if any difference exists between the visual and actinic foci, it will be found that the centre division, which was sharp on the screen, is not sharp in the photograph, but that some other division more or less distant from the centre of the scale is. Replace the focusing screen and ascertain how much the fine-adjustment has to be moved to bring sharp on the screen the particular division that was

* Journ. Liverpool Micr. Soc., i. (1891) pp. 99–110.

sharp in the photograph. This will give the measure, for that objective, of the difference between the two foci, and whenever the same objective is used, you can always, by moving the fine-adjustment to that extent, but in the opposite direction, convert the visual into an actinic focus.

In 1859 I left England for India, and for nearly thirty years, having "other fish to fry," being, in fact, engaged in the "struggle for existence," I had no leisure for microscopical studies. On recently resuming, about two years ago, one of the first things I did was to read up what had in the meanwhile been done as regards photomicrography. What a change had taken place, whether regarded from the photographic or the microscopic point of view! I found that there were now available gelatino-bromide plates, infinitely more sensitive than the old collodion, and dry instead of wet, so that there need be no limit to the time of exposure. On the other hand, "immersion" objectives, followed by apochromatics, had greatly increased the delineating power of the Microscope. I promptly provided myself with a set of apochromatics, and proceeded to mount my old hobby, intending to apply it chiefly to the investigation of the minute structure of the diatom valve. I commenced with daylight (white cloud) illumination, which in the old days had been considered the best; next proceeded to artificial light (oxy-hydrogen); and finally adopted, for high magnifications, sunlight, with which Colonel Woodward had achieved his best results. My wish is to place before you to-night some of the results that I have so far obtained; to describe the apparatus I use in its present state of development, and explain, so far as I can without a "practical demonstration," the method of working with it.

A general idea of the apparatus you will gather from the woodcuts and description, which originally appeared in the Royal Microscopical Society's Journal, 1890, pp. 429–34.

[We omit the description and figures of the Microscope and heliostat as they were dealt with in the Journal, 1890.]

Turning now to the camera. This is fixed to a base-board, which pivots on a tripod, so that it can be slewed round out of the way when not in use. There is then room for the operator to sit at the Microscope, find and arrange his object, and adjust his illumination, also to effect the necessary corrections of the object-glass for variations in the thickness of the cover-glass, if an eye-piece is to be used; but if the photograph is to be taken without an eye-piece, this correction should be effected after the camera is attached, and when the image is on the ground glass. It is well for the table upon which the Microscope stands to be of such a height as to bring the tube of the instrument comfortably to the level of the observer's eye, and the height of the tripod must correspond, being such that the axis of the camera coincides with that of the Microscope. The light-tight connection of the camera to the Microscope can be effected in a variety of ways. The one I employ is a collar, covered with velvet, which fixes on to the upper end of the draw-tube of the Microscope, and has a deep groove, into which fits a wide brass tube attached to the camera front by a small conical bellows.

The image of the object may be projected on to the sensitive plate either (1) by means of the object-glass alone, or (2) by the use of what is termed a "projection" eye-piece. Much good work has been done by the former method, but not, so far as I can judge, the very best. I

attribute this partly to the fact that in English objectives the spherical and/or chromatic aberration is often not entirely corrected, some being intentionally left for correction by a contrary error in the eye-piece; but chiefly to the object-glass being adjusted to project the image a fixed distance, which is generally 10 in., that being the usual length of the English Microscope-tube: but when the image is projected not to 10 in., but to a distance considerably exceeding this, say to a distance of 40 or 50 in., the corrections are altogether disturbed, and the delineation in consequence deteriorated. A main cause of the disturbance can be removed in object-glasses provided with a collar adjustment for cover-correction, by altering the relative distance of the different combinations of lenses in the object-glass; and I have had even a $1\frac{1}{2}$ in. objective mounted so that the distances between the lenses could be changed; but other causes of disturbance are left, or even increased, by the change, and the image is never so clear as it is at the 10 in. A projection eye-piece, however, avoids this difficulty, for it takes up the image at the proper distance, and is furnished with means for adjusting its own action to whatever distance the sensitive plate may be placed. I have used Zeiss's, but I believe several English makers supply similar ones. You will see that there are two combinations of lenses, the distance between which can be regulated, and the adjustment thereby effected. It is correct when the edge of the field is sharp and clear.

The method of illumination may vary according to the work to be done. For moderate magnification, say up to about 300 diameters, I have found diffused daylight from cloud or blue sky to give good results. The same light, or a good lamp, can also be used for higher magnification, 500 or even 1000 diameters; but the light is then so feeble that focusing is difficult, and a very long exposure necessary. I show you one photograph of a Triceratium, × 1000, taken with diffused daylight, for which the exposure was 1 hour 40 minutes; and another of an Arachnodiscus, × 800, taken with a paraffin lamp, and an exposure of 1 hour 20 minutes. With such prolonged exposures the chances of vibration, or of changes of focus arising from the expansion or contraction of the instrument in consequence of variations of temperature, are greatly increased; so that the final result is seldom so clear and sharp as with a more intense illumination and shorter exposure. For high magnification, therefore, oxy-hydrogen light is usually employed; and better even than this I consider sunlight. It has, of course, some serious disadvantages. It cannot be obtained whenever you happen to require it by merely turning on a tap. You are dependent upon the clerk of the weather; and when you do get it, it is too apt to be intermittent. Many a time I had to wait patiently, waiting for a break in the clouds. But when you do get it, I think it is the *ne plus ultra*. When using it, exposures can be reckoned by seconds, and I have a negative of *Pleurosigma angulatum*, good so far as density is concerned, taken with an exposure of only one second to sunlight, on an ordinary Ilford plate. Whether the source of illumination be a lamp, or a lime cylinder, or the sun, care must be taken so to focus the sub-stage achromatic condenser, that an image of the source of illumination is thrown on the exact plane of the object. This is all-important.

I will now try to describe, with some minuteness, my course of procedure when taking a photograph by sunlight, premising that my objects

are generally diatoms, and the magnification 1000 diameters. The Microscope is placed in its horizontal position, and the milled head of its fine-adjustment brought into gear with the focusing-rod by means of a piece of thin whipcord. The heliostat is placed in front, on a wooden stand, which carries also the fixed mirror and the alum-cell for absorbing heat-rays. Care has to be taken that the optical axis of the whole apparatus is directed due south, which is insured by the end of the board upon which it stands being cut at such an angle that when this end is placed against the plate glass of the window, all is in right direction.

The first operation is to accurately centre the achromatic condenser, using a two-thirds objective and regulating the diaphragm so that its opening may be a little smaller than the field; next, to centre the further diaphragm at the end of the brass plate; and afterwards, removing the movable mirror from the heliostat, to ascertain that the spindle appears precisely end on and in the centre of the field, which it should do if the heliostat has been properly placed. Exactness in this last adjustment is necessary, otherwise the beam of sunlight will not be motionless. The movable mirror is then replaced on the spindle, and set to reflect the image of the sun in the centre of the field. At this stage the eye must be protected by a dark-coloured glass being placed below the condenser. The object being placed on the stage, brought into the centre of the field and focused, the condenser has next to be focused to throw the sun's image exactly in the plane of the object. Sharpness of the ultimate image upon the ground glass cannot be secured without this.

Changing the objective to a one-sixth (4 mm.) I next measure the thickness of the cover-glass, or rather the distance between that plane of the object which it is desired to photograph and the upper surface of the cover-glass, by means of the fine-adjustment screw. The purpose of this is twofold. First, to facilitate cover-correction; secondly, to ascertain whether the 2 mm. object-glass, which is now put on, can get down to it, for its front lens is rather more than a hemisphere, and the mount in which it is set is so extremely thin that it has hardly any grip on the lens, and the slightest pressure suffices to displace it. My glass, with a distance of 0·18 mm. between the object-plane and the upper surface of the cover-glass, requires no correction. For a thinner cover—and the covers of English-mounted slides generally are thinner—correction is effected by lengthening the tube-length; for a thicker cover, by shortening it. Lastly, the illuminating cone thrown by the condenser has to be regulated. You are probably aware that there is great controversy as to what this should be in order to produce a "true" image. My experience is that the width of the cone should vary according to the nature of the object and the quality of the object-glass. Too narrow a cone produces diffraction fringes, that bane of photomicrography; too wide a cone, even, I think, with the best objectives hitherto made, produces haze. With thin "test objects" I find my own glass works best when about two-thirds of its back lens is filled with light; for thick objects, I get the best results with a somewhat narrower cone. Of one thing I am convinced, that to get true images, the cone, whether it be wide or narrow, must be absolutely axial. Even a very slight obliquity renders the images unreliable.

The ordinary eye-piece is now changed for a projection eye-piece, set to the distance at which the sensitive plate is to stand; the camera is attached, and the long focusing-rod coupled on. The image of the sun will be found in the centre of the ground glass. If it is not, the centering of the condenser must be wrong, and will require alteration. The sun's image should be sharp at the edge, unless the sky is hazy. Any light fleecy clouds near the sun will be visible on the screen, almost as if an ordinary landscape lens were being used, and the effect when they drift across the sun's disc is very curious. The image of the object, as seen against that of the sun, will be somewhat out of focus, but a slight turn of the focusing-rod brings it right.

With sunlight I find it unnecessary to use anything for focusing except the ground glass. The image is so bright that the details can be sufficiently seen. With other less brilliant sources of illumination it is necessary to use other means; and that which I have found most convenient is a Microscope eye-piece. The ground glass is removed, and replaced by a wooden slide, in the centre of which is a hole fitting the eye-piece. It should be so set that the diaphragm of the eye-piece is in register with the sensitive plate. Even a very faint image, when viewed through this eye-piece, is sufficiently visible to admit of focusing.

The next step is exposure. I wish I could give you some rule by which to regulate exposure, but I find it altogether impossible to do so. Its wide range has already been indicated. From one second with bright sun, to an hour and forty minutes with diffuse daylight, is a "far cry." Exposure depends not only on the source of light, but on variations of that source. A winter sun, shining through an east wind haze, is very different from a midday sun in summer, when the sky is clear. Exposure varies, too, with the degree of magnification. A magnification of 1000 diameters requires 100 times the time that one of 100 diameters requires. It varies with the width of the illuminating cone. It varies with the opacity or transparency of the object. It varies with the colour of the medium in which the object is mounted. A diatom mounted in Prof. van Heurck's high refractive medium, which is of a deep yellow colour, requires at least six times the exposure that would be proper if it were mounted in balsam, all other conditions remaining equal. All I can tell you, therefore, is that a little experience, and a few dozen spoiled plates, of which notes have been kept, will enable you to judge, almost instinctively, what exposure is required. I always make two exposures on each object, one longer than the other, and thus have a double chance.

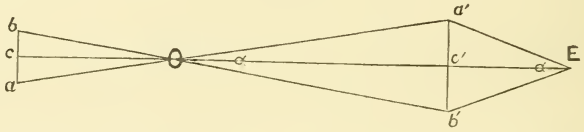
As regards plates, I recommend you to use slow ones, and to develope with hydroquinone. The usual difficulty, with most microscopical objects, is to obtain sufficient contrast, and this is most readily obtained on slow plates."

FRAZER—On Photography as an aid in Anatomical, Histological, and Embryological Work.
Report 59th Meet. Brit. Assoc. for the Advancement of Science, 1890, p. 639.
PRINGLE, A.—Practical Photomicrography by the latest methods.
New York, 1890, 8vo, 192 pp., 7 pls.

(5) Microscopical Optics and Manipulation.

Microscope Magnification.*—Mr. W. Le Conte Stevens, in spite of the distinction drawn by some authors between "magnification" and "amplification," † sees no good reason for discarding the usual acceptation of the term magnification, as denoting the ratio of the diameters of the retinal images produced with and without the magnifying instrument respectively. To obtain the magnification of a Microscope it is necessary to know the equivalent focal length of the eye-piece and objective, and also the tube-length. Unfortunately all of these data are seldom supplied by the makers. The equivalent focal length of the eye-piece is rarely given, and great diversity exists as to the points to be taken as the limits of tube-length. The tables of magnification given by certain firms are only applicable when "standard tube-length" is used, and such a standard exists only in name. Examination of such a table supplied by one maker showed that the magnification was calculated by dividing 100 by the product of the focal lengths of objective and eye-piece. This rough approximation is deduced as follows:—

Fig. 49.



Let $a'b'$ (fig. 49) denote the image of the object ab given by the objective O. O c is taken as the focal length of the objective, and O c' as the tube-length, 10 in. The magnification of the objective m is then given by

$$m = \frac{a'b'}{ab} = \frac{10}{f}.$$

The eye-piece increases the visual angle from α to α' producing a virtual image assumed to be 10 in. away. For the magnification m' of the eye-piece whose focal length is F we have

$$m' = \frac{\tan \frac{1}{2}\alpha'}{\tan \frac{1}{2}\alpha} = \frac{10}{F}.$$

The total magnification M is then

$$M = m\,m' = \frac{100}{f\,F}.$$

A more exact formula is obtained as follows:—For the objective we have

$$m = \frac{a'b'}{ab} = \frac{T}{O\,c},$$

where T is the tube-length defined as the distance from the focal plane to the point which behaves as an optical centre.

* Amer. Journ. Sci., xl. (1890) pp. 50–62. † See this Journal, 1889, p. 818.

But

$$\frac{1}{\mathrm{O}c} + \frac{1}{\mathrm{T}} = \frac{1}{f},$$

$$\therefore \quad m = \frac{\mathrm{T}}{f} - 1.$$

For the eye-piece

$$m' = \frac{\mathrm{D}}{\mathrm{F}} + 1,$$

where D is the distance of distinct vision

$$\therefore \quad \mathrm{M} = m\,m' = \frac{(\mathrm{D} + \mathrm{F})\,(\mathrm{T} - f)}{\mathrm{F}\,f}.$$

The equivalent focal length of the eye-piece can be easily calculated, if the focal length of the eye-lens is known. Thus by the formula for the combination of two lenses

$$\frac{1}{\mathrm{F}} = \frac{1}{f'} + \frac{1}{f''} - \frac{d}{f'\,f''},$$

where f' f'' are the focal length of eye-lens and field-lens respectively, and d is the distance between them.

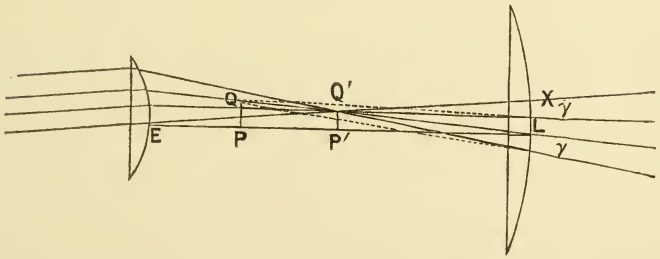
But in the case of a properly constructed negative eye-piece $f'' = 3f'$ and $d = 2f'$, so that $f' = \frac{2}{3}\,\mathrm{F}$.

To determine f' the magnification of the eye-lens can be measured by the use of the camera lucida. A micrometer is placed at the diaphragm of the eye-piece, and the Microscope is inclined until the optical centre of the eye-lens is 250 mm. (distance of distinct vision) above the paper, on which the camera lucida projects the figures of the micrometer. The magnification m' is thus directly determined and f' given by the formula

$$m' = \frac{\mathrm{D}}{f} + 1.$$

Fig. 50 explains the theory of the negative eye-piece, and shows how

Fig. 50.



the effect of the field-lens is to diminish the magnification by two-thirds. The rays $r\,r$ converging from the objective to the point Q, are made

more convergent by the field-lens L, so as to cross at Q′ in the principal focal plane of the eye-lens E.

We then have

$$\frac{1}{\mathrm{L\,P'}} - \frac{1}{\mathrm{L\,P}} = \frac{1}{f'},$$

$$\text{i.e.}\quad \frac{1}{f'} - \frac{1}{\mathrm{L\,P}} = \frac{1}{3f'},$$

since in a negative eye-piece $\mathrm{E\,L} = 2f'$ and $f' = 3f'$.

$$\therefore\quad \mathrm{L\,P} = \frac{3}{2}f' \quad \text{and} \quad \mathrm{P\,Q} = \frac{3}{2}\mathrm{P'\,Q'}.$$

The focal length of the objective is best determined by the formula of Prof. C. R. Cross.* A micrometer scale divided into tenths of a millimetre is placed on the stage, and a second, divided into millimetres, at the diaphragm in the focal plane of the eye-lens, the field-lens being removed. The magnification m of the objective is then given by focusing the image of the stage micrometer upon the eye-piece micrometer.

If p, p' denote the distances of the two micrometers from the point which behaves as optical centre of the objective, we have

$$m = \frac{p'}{p}.$$

And if l is the distance between the micrometers

$$l = p + p'$$

$$\therefore\quad p' = \frac{m\,l}{m+1}.$$

Then from the formula

$$\frac{1}{p} + \frac{1}{p'} = \frac{1}{f}$$

we have

$$f = \frac{m\,l}{(m+1)^2}.$$

Determinations, made by use of the above formulæ, of the focal lengths and magnifications of the eye-pieces and objectives of various makers showed how generally erroneous was the labelling. In the case of five eye-pieces of one of the best known of American makers, the percentage of error in the value of F varied from 2·7 to 7·4, and in no case was $f' = 3f'$ or $d = 2f'$. In ten out of eleven objectives examined, the percentage of error was greater than 4, and for two of them it reached as high as 41 and 50. Application of the formula $\mathrm{M} = \frac{100}{\mathrm{F}f}$ for various combinations was shown to give very inaccurate results as compared with determinations of the magnification made by the camera lucida.

For the application of the more exact formula $\mathrm{M} = \frac{(\mathrm{D}+\mathrm{F})\,(\mathrm{T}-f)}{\mathrm{F}f}$

* Journ. Franklin Institute, lix. p. 401.

which gives perfectly reliable results, it is necessary that makers should have accurate values of the equivalent focal length of eye-piece and objective stamped on their mountings, and also the tube-length stamped on the body-tube.

A standard tube-length should be agreed upon. The author considers that of 180 mm. of Continental makers more convenient than the 10 in. generally adopted in England and America. The upper limit of the tube-length should be the focal plane in which an image would be formed by the objective if there were no field-lens. In a negative eye-piece this plane is midway between the diaphragm and the optical centre of the eye-lens. Eye-pieces should therefore be so constructed that when slipped into position this plane should be exactly at the top of the body-tube. Such par-focal eye-pieces have been made for several years past by the firm of Zeiss. The lower limit of the tube-length should be the point within the objective which behaves as an optical centre. The distance from the top of the body-tube to the extremity where the objective is screwed on is taken a little shorter than the desired tube-length, say 160 mm. instead of 180 mm. Then in the formula $\frac{1}{p} + \frac{1}{p'} = \frac{1}{f}$, $p' = 180$ and p can be calculated, since f is known. Subtracting then from p the working distance between slide and the exposed lens, we have the distance within the objective of the point which acts as an optical centre. Allowance can then be made in the mounting of the objective to make this point just 20 mm. from the extremity of the body-tube where the objective is screwed on.

β. Technique.*

Arloing, S.—**Cours élémentaire d'anatomie générale et notions de technique histologique.** (Elementary Course of General Anatomy and Histological Technique.) Paris, 1890, 8vo, 388 figs.

Behrens, W.—**Leitfaden der botanischen Mikroskopie.** (Outlines of Botanical Microscopy.) Braunschweig (Bruhn) 1890, large 8vo, 288 pp., 150 figs.

Bonnet, R.—**Kurzgefasste Anleitung zur mikroskopischen Untersuchung thierischer Gewebe.** (Concise Introduction to the Microscopic Examination of Animal Tissues.) München (Rieger) 1890, 2 figs.

Paul, F. T.—**On the relative Permanency of Microscopical Influence of the different Staining and Mounting Agents.** *Liverpool Med.-Chirurg. Journ.*, X. (1890) p. 65.

(1) Collecting Objects, including Culture Processes.

Method for making Permanent Cultivations.†—Herr W. Praus-nitz preserves roll and puncture cultivations (and even liquid ones provided the liquefaction is not too general) by filling the tubes with a gelatin solution to which a disinfectant has been added. The tubes are placed in ice-water, the cotton wool plugs removed, and the fluid and antiseptic gelatin solution is then slowly poured in through a pipette. The tube is then plugged with a cork cut off flush with the top, and finally

* This subdivision contains (1) Collecting Objects, including Culture Processes; (2) Preparing Objects; (3) Cutting, including Imbedding and Microtomes; (4) Staining and Injecting; (5) Mounting, including slides, preservative fluids, &c.; (6) Miscellaneous.

† Centralbl. f. Bakteriol. u. Parasitenk., ix. (1891) pp. 131-2.

sealed over in order to prevent the gelatin from drying. The disinfectants recommended are 5 per cent. acetic acid, or 1 per cent. carbolic acid. The gelatin solution is of course a simple one, and without any additions; it is clarified by means of egg albumen, and the acid added after filtration.

By this method the author preserved cultivations for two years, but he admits that sometimes, for reasons inexplicable, the gelatin liquefies.

Simplified Method for preparing Meat-Pepton-Agar.* — Mr. N. Tischutkin prepares and filters meat-pepton-agar in the short time of 2–2½ hours. The requisite quantity of agar is placed for 15 minutes in a dilute solution of acetic acid (5 ccm. acid. acet. glacial. in 100 ccm.). The swollen agar is then carefully washed free from acid and then mixed with bouillon. Boiling for 3–5 minutes suffices to make a perfect solution of the agar in bouillon. After neutralizing and cooling down the whites of two eggs are added, and the mixture placed for half to three-quarters of an hour in a Koch's steamer. It is next filtered through Schulze's paper.

Preparing Nutrient Agar.†—Prof. van Overbeek de Meyer prepares nutrient agar in a very satisfactory manner by the aid of his disinfection oven, which insures a constant temperature of 100° to 101°. The agar is cut up into very small pieces and in the proportion of 1½ to 2 per cent. is poured into 0·5 litre of Loeffler's bouillon. To this is added 1 per cent. pepton, and 0·5 per cent. common salt.

After the lapse of about an hour, the mixture is placed in the disinfection oven, and there steamed for three-quarters of an hour at 100°. This dissolves the agar and separates out the coagulable albuminoids.

The next step is to neutralize or impart any suitable reaction to the solution, after which it is filtered through blotting-paper into flasks. The funnel is covered over with a glass, and the funnel, flask, and cover are again placed for three-quarters to one hour in the disinfection oven. In the end about 0·25 litre of perfect bouillon-agar are thus obtained. If requisite any additional substances, such as grape-sugar, glycerin, &c., may be added, after which the mass is sterilized for half an hour, and the process repeated on the two following days.

Cultivating Actinomyces.‡—Herren N. Protopopoff and H. Hammer cultivated Actinomyces on glycerin agar bouillon, potato gelatin, and in milk and eggs. The cultivations were derived from a pure cultivation prepared by Prof. Afanassiew from the pus of a person affected with actinomycosis.

By rubbing granules of the agar cultivation together with sterilized bouillon and inoculating with this emulsion, a much more rapid development was obtained than by direct transference of the granules. On glycerin agar the cultivation presented a mass of miliary granules, about the size of hemp-seeds, of a yellowish-white colour, and firmly

* Wratsch, 1890, No. 8. See Centralbl. f. Bacteriol. u. Parasitenk., ix. (1891) p. 208. † Centralbl. f. Bakteriol. u. Parasitenk, ix. (1891) pp. 163–5.

‡ Zeitschr. f. Heilk., xi. (1890). See Centralbl. f. Bakteriol. u. Parasitenk., ix. (1891) pp. 63–4.

fixed to the medium. On potato the growth was particularly luxuriant and quite typical, the cultivation having a characteristically dry appearance. In bouillon the miliary nodules soon appeared, and grew up into masses the size of a hazel-nut, the bouillon remaining clear. In milk, the ray fungus throve well, the albuminoids of the milk being apparently directly peptonized without previous coagulation.

The authors found that the growth of the fungus was completely stopped at a temperature of 52° C. and that even 40° C. exerted an inhibitive action.

The authors further observed that the fungus presented in their cultivation a cyclical polymorphism, that is, the Actinomyces filaments, at first distinguished by their dichotomous ramifications, eventually assumed, by continual subdividing transversely and longitudinally, the appearance of rodlets and cocci, from which again developed the long branched filaments.

This variety of polymorphism was specially observable in potato cultivations, while in old cultivations real retrograde metamorphoses, e. g. club-shaped or spirilla forms, mucous degeneration, &c., were remarked.

The authors regard the rosette form found in men and beasts as the expression of a parasitic adaptation to the animal body.

Further experiments showed that in old cultivations the further development of the cultivation was inhibited in consequence of the accumulation of metabolic products.

The results of the experiments on animals are reserved for a further communication.

Apparatus for facilitating Inoculation from Koch's Plates.*—Herr W. Prausnitz has devised an apparatus for facilitating the inoculation of particular colonies from Koch's plates.

It consists of a metal ring which is screwed on to the Microscope-tube. From one side projects a metal piece, in which is left a linear fissure for the insertion of a platinum plate. From the lower end of the plate is excised a triangular piece. The inoculating needle is made to rest in the angle of the platinum plate, its point being about 2 mm. from the colony. The apparatus is merely intended as a device for keeping the needle steady, so that the special micro-organisms only are removed, and uncontaminated either by the medium or by adjacent colonies.

Picric and Chromic Acid for the rapid Preparation of Tissues for Classes in Histology.†—Mr. S. H. Gage remarks:—"The standard methods of hardening tissues and preparing them for sectioning require so great an expenditure of time that it is practically impossible for students in college and carrying on other university work to perform all the processes and to make any satisfactory progress in the limited time devoted to histology. Believing firmly that unless a student learns to take every individual step himself in histology, as in all other branches of sound learning, the great object is unattained, I have been experimenting for the

* Centralbl. f. Bakteriol. u. Parasitenk., ix. (1891) pp. 128–9 (1 fig.).
† Proc. Amer. Soc. Micr., 1890, pp. 120–2.

last few years in the laboratory, hoping to so shorten and modify existing methods that every step may be taken by the student himself without too great an expenditure of time. The following are the results, and they are given, not because they are the best possible methods that might be used if unlimited time were at the disposal of the student, but as methods that give excellent results in a very short time.

Picric Alcoholic Method.—The hardening and fixing solution consists of 95 per cent. ethyl alcohol, 250 ccm.; water, 250 ccm.; picric acid crystals, 1 gram.

The tissue is cut into pieces of moderate size and placed in a preserving jar containing about 25 to 50 times as much of the preservative as there is tissue. It is well also to suspend the tissue or support it on absorbent cotton, or to stir the tissue around occasionally. The tissue should be left in the picric alcohol about 24 hours. If the piece is small, 12 hours will do, and an immersion of 2 to 3 days seems to do no harm. After one day the tissue is placed for 24 hours in 67 to 70 per cent. alcohol, and then for one day or longer in alcohol of from 75 to 82 per cent. It may be left indefinitely in this. Finally, just before imbedding, the tissue is dehydrated one day only in 95 per cent. or stronger alcohol. It may then be infiltrated with paraffin or collodion in the usual manner, the whole time required being 7 days, at the longest, to harden, infiltrate, and imbed a tissue ready for sectioning.

The picric-alcohol method has given excellent results for all tissues except peripheral nerves. It is especially to be recommended for organs or parts possessing ciliated epithelium.

The double stain of hæmatoxylin and picric acid gives very sharply defined appearances, the hæmatoxylin staining the nucleus and the picric acid the cell-body and also the ground-substance somewhat.

If ammonia-carmine is used as a stain, more sharply differentiated appearances are obtained by dehydrating with the following:—95 per cent. alcohol, 100 ccm.; glacial acetic acid, 1 ccm.; picric acid crystals, 1/10 gram.

Nothing has been found more satisfactory for a clearing medium than:—Carbolic acid crystals (melted), 40 ccm.; turpentine (oleum terebinthinæ), 60 ccm.

And for a mounting medium, Canada balsam, dissolved to the consistency of thick syrup in xylol or cedar-wood oil, has given excellent results.

Flemming's Chrom-Acetic Acid Method.—This has proved satisfactory for the rapid fixing of peripheral nerves and for stratified epithelia. For the stomach and intestines it has not proved so satisfactory as the picric alcohol. Chromic acid crystals, 6 grams.; glacial acetic acid, 2·4 ccm.; water, 2400 ccm.

The tissue is cut into pieces of moderate size and placed in 50 to 75 times its volume of the fixing agent for 12 to 24 hours. It is then washed two hours or more in water and left about 12 hours in 50 per cent. alcohol, then placed indefinitely in 75 to 82 per cent. alcohol. It may be dehydrated, infiltrated, and imbedded as described for the picric-alcohol method.

Hæmatoxylin is, on the whole, the most satisfactory stain, but the staining is not so satisfactory as after the use of picric alcohol. The

staining may be hastened in this case, as in all others where it is desirable, by heating the staining agent.*

Apparatus for making Esmarch's Rolls.†—The apparatus devised by Herr N. Prausnitz for preparing Esmarch's rolls consists of a tin box 10 cm. high, 23 cm. broad, and 19 cm. deep. In the middle of the short sides two grooves are cut out for the insertion of a spindle worked by a handle. On the spindle and at a distance of 14 cm. from one another are two circular tin plates, in the periphery of which ten round holes are cut out. When required for use, the box is filled with water heated to 10°–12°, and in the holes are placed test-tubes, filled with liquid gelatin. The handle is then turned until the gelatin is set.

The best results are obtained when the tubes are one-fourth full of gelatin.

New Cultivation Vessel.‡—Dr. L. Kamen gives an account of how he devised a cultivation vessel suitable for the examination of water, &c., and how in its main features it resembles closely that invented by Petruschky.§ The main differences seem to be, from the illustrations given, that the author's vessel is 4 cm. longer and 1 cm. broader, and that the neck is indented at one side only.

A comparison of the two sets of drawings will be quite sufficient for easily understanding the trivial differences between the two forms.

Dixon, S. G.—**An Apparatus for the Collection of Dust and Fungi for microscopical and biological tests.** *Therapeut. Gaz.*, 1890, p. 308.

(2) Preparing Objects.

Demonstrating the Membrane of the Red Corpuscle of Batrachia.‖—Dr. L. Auerbach, after submitting the red corpuscles of Batrachia to a renewed investigation, comes to the conclusion that they are invested with a colourless membrane. This is demonstrable if a drop of blood, carefully protected from loss of fluid, be left alone for some hours. By this time the contents of the corpuscle have receded from the membrane, usually being massed at the poles. On the addition of physiological salt solution, the membrane swells up like a bladder. This may be still better observed after hardening in saturated picric acid solution, subsequently washed out with water. Such a preparation, stained with eosin and anilin-blue, shows the membrane blue and the adjacent layer red. Certain reagents cause the corpuscle to swell up to a thin-walled bladder which bursts, allowing the contents to escape, and leaving an empty sac behind; such are sublimate in 0·1 to 0·25 per cent. solution, 1 per cent. boracic acid, chloride of sodium, and chromate of ammonia in 2 to 10 per cent. solution. In the corpuscle can be distinguished a cortical and medullary substance, the latter inclosing the nucleus. This is well

* If the picric alcohol solution, as given above, is diluted with an equal volume of water, it makes a most excellent dissociating medium for almost all the tissues. It is especially good for epithelia and for smooth and striated muscle. The striation in the striated muscle is exceedingly clear and the longitudinal fibrillation of the smooth muscle is easy to demonstrate.

† Centralbl. f. Bakteriol. u. Parasitenk., ix. (1891) pp. 129–30 (1 fig.).

‡ T. c., pp. 165–7 (2 figs.). § See this Journal, 1891, p. 131.

‖ Anat. Anz., v. (1890) pp. 570–8 (2 figs.). See Zeitschr. f. Wiss. Mikr., vii. (1891) pp. 511–2.

seen after the action of a 1 per cent. aqueous sublimate solution and in picric acid preparations.

After hardening in picric acid, subsequently washed out, the cortical layer may be seen as a very fine network, an unnatural condition, the result of the formation of vacuoles. In sublimate preparations the medullary substance is bestudded with dark granules, while in picric acid preparations it is quite clear, and has the appearance of a hollow space. The nucleoli in the cells of adult animals usually stain blue (cyanophilous), while in the larval condition a few are to be found which stain red (erythrophilous). In the early days of larval life there is a single large nucleolus composed of both substances.

New Characteristics of Nerve-cells.*—Sig. G. Magini, who states that the absence of chromatin in the nucleus is a special characteristic of nerve-cells, as compared with neuroglia-cells, advises for the study of this distinguishing feature methylen-blue, and also, but less effectively, vesuvin and Ehrlich's hæmatoxylin. Carmine staining is quite useless for the purpose. The objects must be hardened in Kleinenberg's fluid, or in absolute alcohol, or in sublimate. Müller's fluid is not at all suitable.

Impregnation of the Central Nervous System with Mercurial Salts.†—Mr. W. H. Cox finds that a uniform impregnation of the central nervous system is obtained when the hardening and impregnating fluids are allowed to act together for two or three months. The reaction of the hardening fluid should be as slightly acid as possible. The fluid which Mr. Cox used consisted of 20 parts of 5 per cent. bichromate of potash, 20 parts of 5 per cent. sublimate, 16 parts of 5 per cent. chromate of potash, 30–40 parts of distilled water. The preparations cannot be preserved under a cover-glass in Canada balsam or dammar, for the acidity of the medium and some other unknown cause spoil them. A freezing microtome must be used, for the alcohol involved in the paraffin or celloidin methods endangers the impregnation. The sections are placed for an hour or two in 5 per cent. solution of sodium carbonate, are washed in water, placed for a short time in absolute alcohol, then in some oil, and finally covered with some rapidly drying resin. If they must be covered with a glass, the resinous layer should be allowed to dry, and then covered with castor-oil. Then the cover-glass is put on and pressed down so as to squeeze out the superfluous oil, or by using styrax, or a mixture of gum-arabic and water, &c., the preparations may be kept intact under a cover-glass.

Preparing Nervous Tissue of Amphibia.‡—Mr. A. Smirnow adopted the methylen-blue injection method for demonstrating nerve-cells of Amphibia. 1/4 to 4 per cent. methylen-blue solutions in 1/2 per cent. salt solution were employed. In from half to three hours after injection the tissues were removed from the animal, and the stain fixed with iodopotassic iodide or picrocarmine or picrate of ammonia. The prepa-

* Atti R. Accad. Lincei Roma—Rendiconti, vi. (1890) pp. 19–23. See Zeitschr. f. Wiss. Mikr., vii. (1891) p. 519.

† Arch. f. Mikr. Anat., xxxvii. (1891) pp. 16–21 (1 pl.).

‡ Op. cit., xxxv. (1890) pp. 407–24 (2 pls.). See Zeitschr. f. Wiss. Mikr., vii. (1891) p. 511.

rations were mounted in pure glycerin, in acidulated glycerin, or in glycerin to which 1 per cent. of picrate of ammonia solution had been added.

Examining Spermatozoa of Insecta.*—Herr E. Ballowitz used male beetles, the vas deferens of which was quite full of spermatozoa. The living spermatozoa were fixed with osmic acid vapour, and usually stained with gentian-violet.

Maceration specimens showing a fibrillation of the flagellum were obtained by removing the wings and upper abdominal wall and then immersing in very dilute sodium chloride solution for some days. A piece of vas deferens was then cut out, carefully washed, and then teased out on a slide in 0·8 per cent. salt solution. A drop of this fluid was covered over with a cover-glass, and after the lapse of one to three days stained with some anilin dye. Movements of the spermatozoa were shown on Schulze's hot stage, the optimum temperature being from 30° to 35° C.

Demonstrating Structure and Termination of Muscular Nerves in Œdipoda fasciata.†—Sig. V. Mazzoni employs the following modification of the gold chloride method for staining nerve-endings. Pieces of muscle, 1 to 2 mm. in size, are placed for half an hour in a watery solution of 1/3 formic acid. When quite transparent they are transferred to gold chloride solution (1:100), wherein they remain for 7 or 8 minutes. After this they are left in the dark for 12 hours in the formic acid solution, and then mounted in glycerin.

Mounting Acarina.‡—M. E. L. Trouessart finds that dried material containing mites makes better preparations than can be obtained from fresh specimens. The material is placed in a large drop of glycerin on a slide, but is not covered. The preparation is then carefully and slowly warmed over a spirit-lamp. By this the animals are cleared up and freed from air-bubbles and any adherent impurities. For imbedding, glycerin-gelatin is recommended, but if it is desired to keep the animals this may be done in alcohol or Hantsch's fluid.

Preparing Eggs of Pycnogonids.§—Mr. T. H. Morgan found the best way of hardening the eggs of Pycnogonids was to put them into alcoholic picro-sulphuric acid for several hours, and then to gradually carry them through different grades of alcohol of increasing strength. After an hour in absolute alcohol, two to four hours in turpentine, one hour of soft and one to two hours of hard paraffin, the eggs were cut in paraffin, and fixed to the slide with albumen fixative. Again, they were passed through turpentine, absolute alcohol, 95, 80, 70 per cent. alcohols to Kleinenberg's hæmatoxylin, where they remained for from twelve to forty-eight hours. They were then washed in acid alcohol for fifteen minutes, and passed through the alcohols and turpentine into balsam. Very excellent results were obtained.

* Zeitschr. f. Wiss. Zool., l. (1890) pp. 317–407 (4 pls.). See Zeitschr. f. Wiss. Mikr., vii. (1891) pp. 503–4.

† Memorie R. Accad. Scienze Bologna, ix. (1889) pp. 547–50 (1 pl.). See Zeitschr. f. Wiss. Mikr., vii. (1891) pp. 504–5.

‡ CR. Séances Congrès Internat. Zoologie Paris 1889, pp. 164–75. See Zeitschr. f. Wiss. Mikr., vii. (1891) p. 502.

§ Studies Biol. Lab. John Hopkins Univ., v. (1891) p. 3.

Preserving Caprellidæ.*—P. Mayer finds that these animals may be preserved without shrivelling by placing them in a mixture of glycerin 1 part and 50 per cent. spirit 2 parts after they are taken from the alcohol in which they have been kept. The alcohol is then slowly evaporated with moderate heat. The author considers that balsam is contra-indicated since on account of its strong refraction the finer skeletal details are imperfectly seen.

Mode of studying free Nematodes.†—Mr. N. A. Cobb collects from sand by applying his knowledge of the fact that, in standing water, sand sinks at once, while small organisms sink rather slowly. "Put half a pint of sand with a pint of water into a dish of the form and size of an ordinary one quart fruit-tin. Having a second beaker or fruit-tin at hand empty, pour the water and sand rapidly back and forth until the water is well roiled, then suddenly stop; the sand at once sinks to the bottom of the dish, but the organisms remain for a few seconds partially suspended. The instant the sand reaches the bottom of the dish, pour the supernatant fluid containing the organisms into a third dish and there let it stand until clear, when the sediment of organisms may be obtained in a very satisfactory state by decanting the clear water." In collecting from mud the process must be reversed.

If the animals are to be studied in the living state they may be rendered motionless by adding a little chloral hydrate to the water. If glycerin preparations are to be made, kill with 1/100 to 1/10 osmic acid and allow the worms to remain in it till they become a trifle coloured. It is best to use warm weak osmic acid.

For the very finest histological as well as coarser anatomical work Mr. Cobb has devised a method which gives far better results than any other with which he is acquainted.

Mode of examining Calcareous Bodies of Alcyonacea.‡—Dr. G. v. Koch says that the easiest way of examining these bodies is to cut a polyp through longitudinally with the scissors, to spread out in glycerin, cover with cover-glass, and observe with crossed nicols. The spicules will appear white on a dark ground and are generally very distinct. The same method may be employed with particles of cœnosarc.

Demonstrating Structure of Siliceous Sponges.§—Herr F. C. Noll succeeded, by treating with nitrate of silver, in showing that the spicules of *Desmacidon Bosei* were covered with an organic layer, the exact origin of which would appear to be uncertain. The same reagent was used with advantage in examining *Spongilla*. Small pieces of sponge were suspended on the slide in the aquarium, and when they had properly spread themselves out, were treated for about twenty minutes with 0·25 per cent. silver nitrate, and afterwards stained with picrocarmine. The flat epithelium was by this means well preserved. For imbedding,

* Fauna u. Flora d. Golfes v. Neapel, Monogr. xvii. (1890) pp. 157 (7 pls.). See Zeitschr. f. Wiss. Mikr., vii. (1891) p. 501.

† Proc. Linn. Soc. N.S.W., v. (1890) pp. 450–2.

‡ Mittheil. Zool. Stat. Neapel, ix. (1891) p. 655.

§ Abhandl. d. Senkenbergischen Naturf. Gesellsch., xv. (1888) pp. 1–58 (3 pls.). See Zeitschr. f. Wiss. Mikr., vii. (1891) pp. 497–8.

Canada balsam was found unsuitable, but good results were obtained with the following medium. Glycerin-gelatin is mixed with equal volumes of acetic acid and glycerin and warmed up until all the constituents have become thoroughly mixed. At a temperature of 12° R. the mass is fluid but below this it is necessary to warm it before using it. If the mass under the cover-glass be not quite firm it is advisable to ring the preparation round with some cement.

Demonstrating the Structure of Rotten-stone.*—Herr F. Dreyer adopted the usual procedure for examining the structure of rotten-stone and the distribution of the Radiolaria, viz. grinding down to one flat surface, then fixing this with balsam to a slide and then grinding down the other side, followed by balsam and cover-glass.

Isolation of the skeletons of the organisms was effected by the following ingenious device. A saturated solution of Glauber's salts was heated in a test-tube and pieces of rotten-stone, dried in the air, dropped therein. By this means they were thoroughly saturated and as they cooled down the process of crystallization effectually pulverized them. If the siliceous skeletons only be desired the following procedure is more simple. Small pieces of rotten-stone are boiled for a short time in hydrochloric acid, the carbonate of lime is dissolved and the thus separated skeletons fall to the bottom as a fine meal. The material should be washed with water in a large glass vessel, stirred up and allowed to stand for one or two hours. The supernatant fluid is pipetted off and the washing repeated several times. Finally, the material is dried in the air. By tapping the watch-glass containing some of the material, the finer may be separated from the coarser particles; some of the former can be mounted in balsam.

Collodion-method in Botany.†—Mr. M. B. Thomas advocates the use of collodion rather than of paraffin for infiltrating plant-tissues. The tissue to be treated is first dehydrated and hardened in alcohol. It is then placed in a 2 per cent. solution of collodion made by dissolving 2 grm. of gun-cotton in 100 ccm. of equal parts of sulphuric ether and 95 per cent. alcohol. In this solution it remains from 12–24 hours, and is then transferred to a 5 per cent. solution, where it again remains 12 hours. It is then laid on cork and covered, by means of a camel's hair brush, with successive layers of collodion, until it is quite inclosed in the mass, allowing each coat to dry slightly before applying the next. After a few hours the collodion will be firm enough to section.

(3) Cutting, including Imbedding and Microtomes.

Imbedding and Sectioning Mature Seeds.‡—Mr. W. W. Rowler gives some useful hints as to the best method of imbedding mature seeds in paraffin and preparing them for the microtome. The method described is that in use in the botanical laboratory of the Cornell University.

* Jenaische Zeitschr. f. Naturwiss., xxiv. (1890) pp. 471–548 (6 pls.). See Zeitschr. f. Wiss. Mikr., vii. (1891) pp. 498–99.

† Proc. Amer. Soc. Micr., 1890, pp. 123–7 (3 figs.). ‡ T. c., pp. 113–5.

A Method of Imbedding Delicate Objects in Celloidin.*—Mr. Frank S. Aby writes:—The object, properly fixed and hardened, is placed for twenty-four hours in a mixture of equal parts of alcohol and ether. It is transferred to a thin syrupy solution of celloidin, made by dissolving celloidin in a mixture of equal parts of alcohol and ether. After remaining in this solution for about twenty-four hours, the object is covered with a thicker solution of celloidin and is allowed to remain in the same for about twenty-four hours, when it is ready to imbed on cork.

When ready to imbed the object, a small quantity of the celloidin solution is spread on clean glass (a slide will answer the purpose), and allowed to dry. Then another coat is applied and allowed to dry. This affords a firm celloidin bed upon which the object is placed and arranged, care being taken to place it in the desired position as quickly as possible, before the celloidin begins to harden. The whole is now covered with successive layers of the celloidin solution, until a firm support is built up for the object. When sufficiently dry, the celloidin is removed from the glass by means of a sharp knife, and if necessary, a pair of scissors is used to trim the bed to the proper size and form. It is now ready to imbed on cork.

The top of a cork is coated with celloidin solution and allowed to dry. This is done to prevent air from rising from the cork and forming bubbles in the celloidin. The object, in its matrix of hardened celloidin, is placed in the desired position on the cork, and fastened to it with celloidin. After drying in the air until a layer is formed on the outer surface firm enough to retain the shape, the cork is dropped into 50 per cent. alcohol. Usually the object is ready to cut after remaining in the alcohol one hour.

This method of preparing a bed of celloidin has been employed with very satisfactory results in obtaining sections of embryo chicks. Blastoderms of the earlier periods of incubation have been successfully sectioned. By arranging the embryo on the bed of hardened celloidin, it has been possible to get large symmetrical sections of the blastoderm. Celloidin contracts during the drying process, but by exercise of due care in arranging the blastoderm, distortion may be avoided.

This method of imbedding has given good results in studying *Hydra*, and the preparation of the celloidin bed may be resorted to in almost every case where delicate objects are to be sectioned.

(4) Staining and Injecting.

Vasale's Modification of Weigert's Method.†—Sig. G. Vasale says that Weigert's method for staining central nervous tissue may be rendered less cumbrous by the following procedure, for which three solutions are necessary. (1) Hæmatoxylin 1 grm. dissolved in 100 grm. water by aid of heat. (2) Neutral acetate of copper, saturated filtered solution. (3) Borax 2 grm., ferridcyanide of potash 2·5 grm., dissolved in 300 grm. water.

The sections taken from spirit are placed in solution 1 for three to five minutes, then for same length of time in solution 2, whereon they

* Microscope, xi. (1891) pp. 58–9.

† Rivista Speriment. Freniatria e Med. Legale, xv. (1889) pp. 102–5. See Zeitschr. f. Wiss. Mikr., vii. (1891) pp. 517–9.

become black. They are then washed quickly in water and transferred to solution 3, whereby the ganglion-cells, the neuroglia, and degenerated parts are quickly decolorized, the medullated fibres remaining stained dark violet. Finally, the sections are well washed in water, then dehydrated in absolute alcohol followed by carbol-xylol (3 parts xylol to 1 carbolic acid) and balsam. If a contrast stain be desired, alum-carmine or picrocarmine or Pal's method are recommended.

Upson's Gold-staining Method for Axis-cylinders and Nerve-cells.* —Dr. A. Mercier describes two new methods, the invention of Dr. Upson, of Ohio, for staining axis-cylinders and cells of central nervous system, the results of which are stated to be wonderful. The pieces are hardened in the dark for four to six months in potassium bichromate, beginning at 1 per cent., afterwards increased up to $2\frac{1}{2}$ per cent. The hardened pieces are then washed in water, and after-hardened in spirit, beginning for the first two or three days with 50 per cent. alcohol, and ending with 95 per cent. spirit, until the pieces are of a greenish colour. The sections may be made either with or without imbedding; in any case the sections are to be thoroughly dehydrated before either method is applied.

Method 1. The section is placed for one to two hours in 1 per cent. gold chloride solution to which 2 per cent. hydrochloric acid has been added. Wash in distilled water. Transfer on platinum or paper lifter to following solution for half a minute:—Potash, 10 per cent. solution, 5 ccm.; ferricyanide of potash, a trace. Wash for half a minute in 10 per cent. potash solution. Wash well in distilled water, and transfer to following solution:—Acid. sulfurosum, 5 ccm.; tinct. iodi, 3 per cent., 10–15 drops. Mix, and add liq. ferri chlorid., 1 drop. In this fluid the section is allowed to remain until it assumes a rose colour; it is then thoroughly washed in distilled water, dehydrated in absolute alcohol, oil of cloves, and balsam.

Method 2. The section is immersed for two hours in the following solution:—Gold chloride, 1 per cent., 5 ccm.; saturated solution of ammonium vanadicum, 10 drops; acid. hydrochlor., 3 drops. Having been washed in distilled water, it is immersed for thirty to sixty seconds in the following mixture:—Caustic potash, 10 per cent., 5 ccm.; ammonium vanadicum, a trace; permanganate of potash, 10 per cent., 10 drops. It is again washed in distilled water, and thereupon placed in the following fluid:—Tin solution, 15 drops; aq. dest., 3 ccm.; iron solution, 3–5 drops; acid. sulfurosum, 3 ccm.

The tin solution is made by adding so much chloride of tin to 3 per cent. tincture of iodine until the colour is white or yellowish. The iron solution is a saturated solution of ferrum phosphoricum in aq. dest.

When the section has become red it is then treated as in method 1.

The author states that although this method may appear somewhat complicated, in reality it is not more cumbersome than most other procedures, and that the results are splendid.

Three new Methods for Staining Medullary Sheath and Axis-cylinder of Nerves with Hæmatoxylin.†—Dr. M. Wolters describes the following method for staining the medullary sheath. The nerve-fibres

* Zeitschr. f. Wiss. Mikr., vii. (1891) pp. 474-9. † T. c., pp. 416-73.

appear of a blue-black colour, while the cells are yellow or yellowish brown. The specimens hardened in Müller's fluid and afterwards in alcohol were imbedded in celloidin. The sections were then placed for twenty-four hours in a paraffin stove at a temperature of 45° in Kultschitzky's hæmatoxylin solution (hæmatox. 2 g., alcohol abs. q. s. ad solut., acetic acid, 2 per cent., 100 ccm.).

After this the sections were immersed in Müller's fluid, and then treated with 1/4 per cent. permanganate of potash, after which they were decolorized in acidum oxalicum 1·0, kalium sulfurosum 1·0, aq. dest. 200·0. Then, having been washed in water, they were dehydrated, cleared up, and mounted.

The second method stained beautifully the protoplasmic process of Purkinje's corpuscles in the cerebellum. In this the procedure consisted in hardening and sectioning as before, and then using the following mordant:—Vanadium chloratum, 10 per cent., 2 parts; aluminium aceticum liquidum, 8 parts. Herein the sections remained for twenty-four hours, they were then washed for 5–10 minutes in water, and then having been stained with hæmatoxylin as in the first method, were decolorized with Weigert's fluid.

In the third method the pieces were hardened by Kultschitzky's method,* and after-hardened in 96 per cent. spirit. The section mass was imbedded in either celloidin or paraffin. The sections were then immersed for twenty-four hours in the following mordant:—Vanadium chloratum, 10 per cent., 2 parts; aluminum aceticum liq., 8 per cent., 8 parts. After having been washed for ten minutes in water the sections were placed in the hæmatoxylin for twenty-four hours. The staining was then differentiated with 80 per cent. alcohol to every 200 parts of which 1 part HCl was added.

When they assumed a bluish-red hue the acid was removed in weak spirit, after which the sections were dehydrated in absolute alcohol, cleared up in origanum oil, and mounted in balsam.

By this method the large cells of cerebrum and cerebellum, their protoplasmic processes, axis-cylinders, and the glia-cells were well stained.

Staining Osseous Tissue by Golgi's Method.†—Sig. V. Tirelli found that Golgi's method was suitable for studying osseous tissue, and very advantageous for flat bones; for example, the skull bones of an almost mature rabbit embryo. Against a yellow background the bone-corpuscles stand out stained more or less dark-brown, the staining in the centre of the elements being less pronounced than at the periphery or in the processes.

The reaction does not affect every individual element, but occurs usually in groups of five to thirty; and this is an advantage rather than not, since it allows the recognition of delicate details of structure.

Impregnating Brain of Amphibia by Golgi's Method.‡—Herr A. Oyarzun calls attention to the fact that in Ramón y Cajal's modification

* See this Journal, 1888, p. 510.

† Atti R. Accad. Lincei Roma—Rendiconti, vi. (1890) pp. 24–6.

‡ Arch. f. Mikr. Anat., xxxv. (1890) pp. 380–7 (2 pls.). See Zeitschr. f. Wiss Mikr., vii. (1891) p. 509.

of Golgi's silver method the observance of definite lengths of time for the different stages of the procedure is important. In frog's brain the best results were obtained by allowing the hardening and impregnating fluids to act for twenty-four hours. For the brain of the triton and salamander twenty-four hours were sufficient. If the fluids were allowed to act for thirty to forty hours, the results were very unsatisfactory.

Staining Medullary Sheath of Nerves of Spinal Cord and of Medulla.*—Dr. A. Mercier says the following simple procedures give satisfactory results for sections of spinal cord and medulla. The sections, according as they contain much or little of the chromic acid salt, are immersed in one of the two following solutions:—

Solution 1. Weak alcohol, 100; hæmatox., 2; aq. dest., 100; alum, 2; glycerin, 100.

Solution 2. Strong alcohol, 120; hæmatox., 2; aq. dest., 130; alum, 2; glycerin, 50. Dissolve the hæmatoxylin in spirit and the alum in the water, add to the latter the glycerin, and then mix with the hæmatoxylin in spirit.

Herein the section remains from twelve to twenty-four hours. It is then washed carefully in water, after which it is transferred to a modified Weigert's decolorizer:—Aq. dest., 200; ferricyanide of potash, 6; borax, 4. When sufficiently decolorized it is washed in distilled water, dehydrated, cleared up in oil of clove, and mounted in balsam.

It was found, however, that if the first decolorizing solution were followed by a second composed of potash, 10 per cent., 2 ccm.; aq. dest., 10 ccm.; æther sulphureus, 1 ccm., the differentiation was more satisfactory.

Demonstrating Nerve-end Plates in Tendons of Vertebrata.†—Sig. G. V. Ciaccio adopted the following method for demonstrating nerve-endings in tendons of Amphibia. The pieces were taken from a living animal, or from one just dead, and placed at once in 1/1000 hydrochloric acid, or better in 1/500 acetic acid until they were quite transparent.

They were then immersed for five minutes in a mixture of gold chloride and potassium chloride solutions (1/1000 each).

This imparts a pale yellow colour.

The pieces were next placed in a large quantity of 1/500 acetic acid and kept there in the dark for a whole day, and then exposed to the sun for two or three hours. When the tendon has assumed a pale violet hue, it is taken out and placed for a day in 1/1000 osmic acid solution and finally mounted in glycerin to which 0·5 per cent. of its bulk of acetic or formic acid has been added. The medullated fibres are stained dark violet, their extreme terminations being also violet, but passing into red or blue. The tendon itself is stained a pale yellow or light violet.

Preparing and Staining Testicle.‡—Sig. H. Brazzola in studying the testicle and the formation of spermatozoa, found that Podwyssozki's

* Zeitschr. f. Wiss. Mikr., vii. (1891) pp. 480–3.

† Memorie R. Accad. Sci. Bologna, x. (1890) pp. 301–424 (6 pls.). See Zeitschr. f. Wiss. Mikr., vii. (1891) pp. 507–8.

‡ Memorie R. Accad. Sci. Bologna, viii. (1888) pp. 681–94 (1 pl.); ix. (1888) pp. 79–85 (1 pl.). See Zeitschr. f. Wiss. Mikr., vii. (1891) pp. 516–7.

modification of Flemming's chrom-osmium-acetic acid was very suitable for the purpose. The objects were placed in 60 per cent. and absolute alcohol for 24 hours each, after which they were imbedded in celloidin. The sections were fixed to the slide with Mayer's albumen-glycerin. For staining purposes the Pfitzner-Flemming safranin, afterwards washed out with very dilute acid (0·1 to 0·25) gave the best results. A good double stain was effected with picric acid by Podwyssozki's procedure. Instead of the Pfitzner-Flemming safranin, a saturated aqueous solution of safranin or a 1 per cent. aqueous solution of gentian violet, or better still, one of these followed by the other may be used.

Gram's method followed by eosin made excellent preparations, and these were still better if the sections were further stained with safranin. The chromatin granules, like the mitoses, were stained red, the achromatic substances a pale blue.

(5) Mounting, including Slides, Preservative Fluids, &c.

Deterioration of Mayer's Albumen-Glycerin Fixative.*—Dr. J. Vosseler draws attention to the fact that Mayer's albumen-glycerin is extremely apt to lose its adhesive property after the lapse of a few months.

The loss of this essential property, its *raison d'être* in fact, is usually accompanied by a slight browning of the colour and a decrease of the viscidity, and the change is so gradual that it is easily overlooked. At first the author was inclined to lay the blame on the corks with which the bottles were stopped, or on the salicylate of soda added as antiseptic. Both these views turned out to be untenable. Little or no effect was observed from using different antiseptics, the least unsatisfactory being camphor. After noting that the peculiar decomposition was more liable to take place in summer than in winter, probably from being hastened by the increased light, air, and temperature, the author came to the conclusion that the glycerin was at the bottom of the mischief, and confirms his view by adducing the frequency with which preparations mounted in glycerin deteriorate.

Hints for fixing Series of Sections to the Slide.†—Dr. H. Suchannek has now altogether given up the use of mica plates, and employs glass slides or cover-glasses. These must be perfectly clean and free from grease. If greasy, spirit when run over a slide shows a tendency to form in balls and not to spread itself out in an even layer. The best adhesive is Mayer's albumen-glycerin, which is rubbed on the slide with the finger. The layer should be extremely thin and perfectly even. To this the sections will firmly adhere in about half an hour at a temperature of 40°.

If the sections be thin and betray any tendency to crumpling and will not lie quite flat, then Gaule's method is undoubtedly the best to pursue. This consists in fixing the sections with 50 per cent. neutral alcohol. The slides are then placed on top of an incubator with a sheet or two of blotting-paper interposed in order that the glass may not be heated above 40°. This causes the gradual and regular evaporation of

* Zeitschr. f. Wiss. Mikr., vii. (1891) pp. 457-9. † T. c., pp. 463-6.

the spirit and leaves the section smooth and adherent to its underlay. A higher temperature always fails to get rid of some little amount of moisture owing to the unequal rapidity of the evaporation; hence the author lays it down as an axiom that the lowest possible temperature is an indispensable condition for the production of a successful preparation. The rest of the procedure is that which is commonly adopted.

Preparation of Venetian Turpentine.*—Dr. H. Suchannek, while recording his estimation of the value of Venice turpentine for microscopical purposes,† advises that it be dissolved in neutral absolute alcohol. About equal volumes of these ingredients are mixed together in a tall glass vessel and placed in a porcelain tile oven. It is necessary to shake the mixture frequently. In from twelve to twenty-four hours the turpentine is dissolved and has deposited its impurities, and in from twelve to eighteen hours more it will have acquired the necessary consistence.

Vosseler's Cement and Wax Supports.‡—Dr. J. Vosseler recommends that paper or cardboard slips should be cemented on the slide by means of a cement made of commercial bleached shellac. Thoroughly broken up shellac is placed in a glass vessel, and alcohol of 90–96 per cent. poured over in quantity just sufficient to cover it. The vessel covered over is then placed on a paraffin stove. In a comparatively short time a clear brownish-looking mass of a syrupy consistence results. It is at once ready for use and, according to its inventor, is a very valuable cement.

The wax supports are made out of a mixture of Venetian turpentine and white wax. A quantity of wax is melted in a porcelain vessel, and thereto is added, stirring continually the while, from half to two-thirds its bulk of Venetian turpentine. Addition of turpentine softens, addition of wax hardens the mixture; the desired consistence is easily ascertained by letting fall a few drops on a glass plate or into water.

Although sufficiently plastic or impressionable it adheres very firmly to glass, hence the position of the supported cover-glass may be altered by slight pressure with a needle on one or all of the supports.

The medium may be used instead of the compressorium in the examination of fresh specimens of living Crustacea, the restless movements of which are easily restrained by fixing the cover-glass to the slide.

(6) Miscellaneous.

Use of Polarized Light in Observing Vegetable Tissues.§—M. Amann describes the results of a long series of observations made on the tissues of Mosses under polarized light, which have led to some curious results. The different cell-walls present, under these circumstances, very different appearances, depending largely on their degree of cuticularization; and it is possible in this way to define the characters of the cells belonging to the different organs in a moss, and even to a certain extent to distinguish between the characters presented by different families.

* Zeitschr. f. Wiss. Mikr., vii. (1891) p. 463. † See this Journal, 1890, p. 258.
‡ Zeitschr. f. Wiss. Mikr., vii. (1891) pp. 459–62.
§ Arch. Sci. Phys. et Nat. xxiv. (1890) pp. 502–8.

PROCEEDINGS OF THE SOCIETY.

Meeting of 15th April, 1891, at 20, Hanover Square, W., the President (Dr. R. Braithwaite, F.L.S.) in the Chair.

The Minutes of the meeting of 18th March last were read and confirmed, and were signed by the President.

The List of Donations (exclusive of exchanges and reprints) received since the last meeting was submitted, and the thanks of the Society given to the donors.

	From
Cox, C. F., Protoplasm and Life. pp. 67. (8vo, New York, 1890)	*The Author.*
Slides (3) of sections of Teeth and Bone permeated with coloured collodion	*Mr. T. Charters White.*
Report and Proceedings, Ealing Microscopical Society	*The Ealing Microscopical Society.*

The President said it would no doubt be remembered that at the last meeting, Mr. T. Charters White exhibited some specimens of sections of teeth permeated with collodion. He had now presented three slides to the cabinet of the Society, which would be valuable as illustrations of the results obtained by the process which he described in his paper.

Prof. F. Jeffrey Bell, in reply to the President, said he had not yet read the book on 'Protoplasm and Life,' presented by Mr. C. F. Cox; but he had—as he often did—opened it at the end, where his eye fell upon the words, "Here I must leave the subject, lame and impotent though the conclusion may be." He would take it home, and see if he could not get something better out of it than that.

Mr. J. Mayall, junr., said there was also amongst the donations a copy of the Report and Proceedings of the Ealing Microscopical Society, which was worthy of notice, as it was not often that a society of so little pretension issued such an interesting abstract of its proceedings. Amongst other papers in the report there was one by Mr. Seebohm which had greatly interested him, and there were some others which he thought would also be found very well worth reading.

The President read a letter from Mr. J. Aitken, of Falkirk, dated from Mentone, on "A Spot Mirror Method of Illumination."

Mr. Mayall said the application of an opaque disc to block out more or less of the central portion of the mirror had long been known. In some of the Microscopes made in the last century by Dellebarre, the optician of Delft, Holland, there was a strip of brass 3 in. or 4 in. in length, with disc-like ends of different sizes, blackened or covered with cloth, made to slide under the stage in a spring-clip, and thus exclude the central light from the mirror, and give a more or less dark ground. Other methods had also been adopted by Dellebarre, one of which was to cement discs of black paper of different sizes on the under-faces of glass stage-plates. Central stops were very commonly applied to a disc of

diaphragms rotating beneath the stage. The more modern arrangements of central stops to be used in conjunction with some form of condenser, or with a lieberkühn, were far preferable.

Prof. Bell read an abstract of a paper contributed by Surgeon V. Gunson Thorpe, R.N., on "Some New and Foreign Rotifera" found on the West Coast of Africa, and belonging to the genera *Trochosphæra*, *Floscularia*, and others. The paper had been submitted to their late President, Dr. Hudson, who regarded it as one of great interest, and strongly recommended the Society to print it *in extenso* with the figures.

Mr. E. M. Nelson referring to the subject of his paper read at the meeting of the Society in March last, exhibited two forms of bull's-eye condenser, one of which was made like Herschel's aplanatic, and the other was a new and simpler form than he had previously described, being made of two plano-convex lenses, the mounting of which was also peculiar, and what he considered to be the most useful method. This condenser seemed to answer its purpose admirably, the amount of spherical aberration being only about one-fifth of that which existed in the old form.

Mr. Nelson also read a paper entitled "Further Notes on Diatom Structures as Test Objects," which he illustrated by photographs.

The President said the photographs appeared beautifully clear, and would, he thought, be found of much interest as bearing upon the points to which Mr. Nelson had particularly drawn their attention.

Mr. C. Haughton Gill's paper "On the structure of certain Diatom valves as shown by sections of charged specimens" was read, the subject being illustrated by photomicrographs.

The President thought Mr. Gill's experiments were of great interest; but the subject was so new that discussion could hardly take place, especially in the absence of the author, which he regretted to learn was due to illness.

Mr. Mayall said the problem Mr. Gill had endeavoured to solve was as to the existence or not of cellular structure in diatoms extending through their substance, and this he sought to demonstrate by making chemical depositions of a more or less opaque character, which would probably fill up the cavities sufficiently to be plainly distinguished by the Microscope. He (Mr. Mayall) had some time ago translated a paper which appeared in the Proceedings of the Belgian Microscopical Society, on a process of preparing sections of diatoms by grinding portions of Cementstein from Jutland. The sections obtained in this way were imbedded in the material forming the matrix of the stone, and were filled up by the same material, showing to some extent the points which Mr. Gill had reached in another way. He thought that Mr. Gill's observations were of still greater interest because he had not merely taken a natural formation, but had deliberately experimented with the definite purpose of testing a special point, thus applying to Microscopy what Herschel would have termed an "experiment of inquiry"—a direct questioning of nature on a point that had hitherto been regarded as almost beyond the

sphere of experiment. Dr. Flögel's sections of diatoms made with his unique microtome dealt with the same point by direct experiment, but unfortunately the production of such sections was attended by very great difficulties, and their preservation for inspection by other observers was apparently so uncertain as to be unreliable, judging from the specimens sent by Dr. Flögel to the Society. Mr. Mayall regretted that Mr. Gill's photographs of the specimens he described were so faint that it would be very difficult to utilize them for any photomechanical process of printing for the Journal.

Mr. Mayall said that in Part IV. Vol. I. of the Journal of the Liverpool Microscopical Society there was a paper by Mr. T. Comber, in which he dealt very practically with the processes of photomicrography with sunlight. He was, of course, sorry that this paper did not come directly to the Royal Microscopical Society; but considering the interest which attached to the subject, and the references made recently to Mr. Comber's work, the paper would probably be dealt with rather extensively in the next number of the Journal.

The President asked the Fellows present to bear in mind that the Conversazione was fixed for Thursday, the 30th of April, at which he hoped to see a good attendance, and that the next ordinary meeting would take place on the 20th of May.

The following Instruments, Objects, &c., were exhibited:—

Mr. C. H. Gill:—Six photographs of Diatom Structures in illustration of his paper.

Mr. E. M. Nelson:—Bull's-eye Condensers and Photographs of Diatoms in illustration of his papers.

Mr. C. F. Rousselet:—A slide of *Stephanoceros Eichornii*.

Mr. T. Charters White:—Three preparations permeated with coloured collodion.

New Fellow:—The following was elected an Ordinary Fellow:—
Mr. Wilmot Tunstall.

MEETING OF 20TH MAY, 1891, AT 20, HANOVER SQUARE, W., THE PRESIDENT (DR. R. BRAITHWAITE, F.L.S.) IN THE CHAIR.

The Minutes of the meeting of 18th February last were read and confirmed, and were signed by the President.

The List of Donations (exclusive of exchanges and reprints) received since the last meeting was submitted, and the thanks of the Society given to the donors.

	From
Kölliker, A., Handbuch der Gewebelehre des Menschen . . . Dritte Auflage. pp. xxiv. and 686, text illust. (8vo, Leipzig, 1859)	*Prof. F. Jeffrey Bell.*
Slides (3) of *Cysticercus*	*Mr. T. B. Rosseter.*

Prof. F. Jeffrey Bell mentioned that the book which he had presented was a copy of the third edition of Kölliker's well-known text-book, which he was surprised to find was not already in the Society's library. It would be of much interest also to them to possess copies of the other editions which had been published, and he ventured to throw out the hint that if any Fellows of the Society should be able to present these, they would be valuable as enabling them to trace the advances made in Animal Histology.

The President said he regretted to have to announce that since their last meeting they had lost several of their Fellows by death; amongst these was Mr. Joseph Beck, who was so well known throughout the microscopical world, and who for many years had been a Member of the Society's Council. They had also lost two of their Honorary Fellows, Dr. Carl Von Naegeli, of Munich, and Prof. Leidy, of Philadelphia, both of whom were elected in 1879.

The President notified that the Council had nominated as an Honorary Fellow of the Society, Prof. Thos. Henry Huxley, F.R.S.; and as an ex-officio Fellow, Prof. William Rutherford, F.R.S., President of the Scottish Microscopical Society, whose names were ordered to be suspended for election at the next meeting.

Mr. C. L. Curties exhibited a new form of Mayall's mechanical stage, recently manufactured by Zeiss, which gave upwards of an inch motion each way, and merely required to be clamped on the pillar of the Microscope when wanted for use. The Microscope on which its adaptation was shown was the same as that described by Mr. Nelson a short time ago, except that it was mounted on a horse-shoe foot, so as to give more working room below the stage as suggested by Mr. Mayall.

Mr. J. Mayall, jun., said that, in the study of bacteriology, it was often important to be able to move a preparation of larger size than usual upon the stage, and it was evidently with a view of meeting this requirement that, instead of the ordinary range of movement of about 5/8 in., this stage had been made so as to move nearly $1\frac{1}{4}$ in., which was effected by separating the rackwork vertical movement from the screw lateral movement, placing the latter in a box-fitting in front of the rackwork. He noticed, however, that whilst the vertical movement was rapid, the lateral motion was on the contrary, rather slow. He should have preferred the movements to act about equally. At the first glance, too, he had been somewhat puzzled by the latchet arrangement for clamping it to the Microscope; but its action was really very simple and efficient. A good point was in making the milled heads smaller than usual, and the milling broader, which would be found a matter of great convenience in use. Messrs. Zeiss had hit upon a novel way of accommodating slides of different sizes by applying a stepped base-piece, into the angles of which slides of three different sizes fitted, being held in position by a sliding spring-clip of very simple construction, and which was a novelty in that connection. The expense was necessarily somewhat greater than that of the simple forms made by Messrs. Swift and by Mr. Baker; but then a much greater range of movement was provided, with the

additional conveniences of finders, and the facility of using large or small slides. This stage was well made, and was one of the best forms he had yet seen of that class. He thought, however, that it would be an advantage to have the rack-and-pinion work covered up, as far as possible, to exclude dust, &c., and to protect it from the hands.

Mr. Watson exhibited and described a Microscope which his firm had recently made specially to meet the wants of Dr. Henri Van Heurck, of Antwerp (see *ante*, p. 399).

Mr. Mayall said he did not propose to criticize the workmanship of the new Microscope, as he had not had an opportunity of examining the mechanism and of testing the movements. He understood, however, from the description already published, and from a description he had received, which was about to appear in a new edition of Dr. Van Heurck's work on the Microscope, that Dr. Van Heurck had supplied the specification of the design; his criticism would therefore be limited to the design for which Dr. Van Heurck was responsible. The Microscope was said to be intended specially for photomicrography and high-power work of the most delicate kind. With these aims in view, he must at once express his objection to the fine-adjustment, which was on what was generally known as the Zentmayer system, and which had long been condemned by those who had had special experience in testing fine-adjustments, such as were applied to Microscopes of the highest class. In the Zentmayer fine-adjustment, the bearings extend generally from end to end of the Jackson limb, and in order to secure a sensitive motion portions of the contact surfaces were removed to reduce the friction, and in all cases these bearings had to be left somewhat free, otherwise the motion would either be completely stopped or more or less irregular. Probably no one had made the mechanism more carefully than the late Joseph Zentmayer, in the large Microscope for which he was awarded a gold medal at the Philadelphia Exhibition, 1876, and a silver medal at the Paris Exhibition, 1878, which instrument he (Mr. Mayall) had had in use during several months. He could affirm that, in spite of Zentmayer's excellent workmanship, the fine-adjustment was unsatisfactory, and this he attributed to the fact that the system involved that the coarse-adjustment and body-tube were carried on the delicate bearings of the fine-adjustment, and the strain thus put upon these bearings soon introduced shakiness that was practically intolerable in high-power work. The apparent simplicity and consequent economy of the system had induced many opticians to adopt it, with more or less modification, both in England and in America; but, so far as he was aware, no permanent success had been attained—the radical defects of the system always cropped up sooner or later. He had witnessed a large number of experiments with the system conducted by Ross and Co., who acquired Zentmayer's patent rights in England, and who had spared no expense with a view to rendering it as perfect as possible, but the results were not satisfactory, and other systems had since been substituted by that firm. The adoption of the Zentmayer fine-adjustment by Dr. Van Heurck seemed to him a radical error in the specification, especially in an instrument intended for high-power work. It should be noted that other systems of fine-adjustment had been worked out, which were applicable

to the Jackson model of Microscope, and which were known to be superior. He referred particularly to Swift's fine-adjustment as recently exhibited in the photomicrographic apparatus made for the Royal Veterinary College. In the original construction Messrs. Swift placed the coarse-adjustment in front of the fine-adjustment, so that the delicate bearings supported both; but upon his pointing out that the mistake would really be equivalent to that of Zentmayer, Messrs. Swift at once altered the arrangement, making the fine-adjustment act by itself, and independently of the coarse-adjustment, so that the bearings had no other strain to endure than that involved in the motion of the fine-adjustment. It was clearly Dr. Van Heurck's province to have known of this improvement in fine-adjustments already applied to the Jackson form of Microscope, and to have either adopted it or devised a new and better system.

With reference to the application of a lever fine-adjustment to the substage, having the actuating milled head above the level of the object-stage, by which Dr. Van Heurck claimed that both fine-adjustments could be used simultaneously with one hand, Mr. Mayall said he considered such an arrangement based on a total misapprehension of the essentials of practical microscopy. The position of the milled head was most inconvenient; the observer's fingers were liable to be caught by the stage mechanism; it impeded the freedom of manipulation on the stage, and it stopped the rotation of the stage; moreover, Dr. Van Heurck seemed to have overlooked the fact that the substage focusing motion was only brought into action in commencing an observation, and once being accurately adjusted was hardly touched again, unless for experimental purposes. The focal adjustment of the objective was a totally different factor, demanding incessant manipulation in many high-power investigations. He could not imagine what possible motive Dr. Van Heurck could have in view when he claimed as a point of utility the faculty of using both fine-adjustments simultaneously. Fine-adjustments had long been applied to the substage. Mr. Nelson had had one carried out by Messrs. Powell and Lealand, by means of a cone-pointed screw and stud mechanism. He had had this arrangement applied to his own Microscope, and he regretted to have to confess his disappointment with it, for it had introduced a new element of unsteadiness that was far more difficult to cope with than the former difficulty of focusing the condenser with the ordinary rack-and-pinion, which the fine-adjustment was intended to correct. A differential-screw mechanism had been applied by Mr. C. L. Curties, at the suggestion (he believed) of Mr. W. Lombardi, and this was embodied in Baker's recently-made photomicrographic apparatus, which was exhibited at the Society's Conversazione in November last. Various forms of direct-action screw arrangements had been applied for the same purpose on the Continent. Hence, it could not properly be said that Dr. Van Heurck had discovered an important point hitherto neglected, and forthwith devised special and novel mechanism by which an essential improvement was effected in the Microscope as an instrument of research.

The general design of the instrument seemed to have been copied from Bulloch's Histological Microscope, and he was surprised that the single pillar support should have commended itself to any one in these

critical days. The milled heads of the mechanical stage seemed inconveniently large, especially when compared with those of Zeiss's stage that was shown that evening. The centering motions of the substage seemed to be of an ordinary cheap type, that could hardly be compared with the best right-angled motions known. The stud at the back of the Jackson limb for fixing the Microscope on a support when used for photography was evidently suggested by Swift's Microscope, to which reference had been made.

Mr. Mayall concluded by expressing his regret that Dr. Van Heurck's specification should have resulted in the production of the Microscope exhibited. In view of the enormous number of Microscopes that had been figured and described in the various text-books, and in the Journal of the Society, it appeared to him that Dr. Van Heurck had made a most inferior selection of points for his specification, resulting in an instrument the design of which he (Mr. Mayall) regarded as much below the standard claimed for it by Dr. Van Heurck.

Mr. E. M. Nelson said that as regarded the method of working the fine-adjustment of the substage, he agreed with Mr. Mayall that the position of this head was inconvenient, and it might also easily interfere with the rotation of the stage; indeed, he hardly knew why it was wanted at all, because when once the substage was focused it was done with and remained the same through the rest of the operations, whereas the other adjustments were being worked almost continually. He thought, therefore, that it would be an improvement if it was put on the other side of the Microscope, and on the under side, so as not to impede the rotation of the main stage.

Mr. Watson said he had heard the criticisms which had been made, but would take one exception to them all—namely, that no one could properly judge of any Microscope unless he had tried it; and because it happened that Mr. Mayall once had a Zentmayer Microscope and it went wrong, he was not prepared to admit that therefore no others would keep right, knowing, as he did, how many of similar construction he had made and sold without even one ever being returned as faulty. As to the No. 1 Zentmayer model, he could quite understand how it was possible for that to work loose and become useless; but as regarded such as were made in the same way as the one before the meeting, he had demonstrated to his own satisfaction that it was quite possible to make a Microscope in which the adjustments were perfectly firm, and would remain so with any amount of ordinary usage. Dr. Van Heurck in ordering this form did not do so without experience, but gave as his reason that the Microscope with which he was supplied by their firm, and in which the principal points were the same, had been in use for three or four years, and was now as good as ever. In his letter to them he said that he had Microscopes in his possession by all the best English and Continental makers; but the one he had from them had proved to be so satisfactory that it was preferred for use to any other. He thought that in matters of this kind an ounce of practice was worth any amount of theory, and for his part he did not see why, if an Englishman brought out a Microscope, because some one in another country made something like it which was bad, therefore, the English article was to be condemned. As to the substage adjustment, that had also

been considered, and found to be very much more convenient where it was than if put under the stage, and it did not stop the rotation of the stage for any practical purpose, it being impossible to give the stage a complete rotation. Putting it round on the other side would certainly be no improvement, and he appealed to practical men as to how they would like to have to turn round to the other side of the instrument to get at it. On the points raised he would therefore say that his judges should be the people who used that form, and not those who merely theorized about it.

The President suggested that Mr. Mayall had not spoken of the instrument which Mr. Watson exhibited, but merely as to the principles of the construction.

Mr. Watson said that was just his point, and he maintained that it was quite possible to make a Microscope on those principles which should stand the test of practical use.

Dr. Dallinger said it appeared to him that when an instrument of that or any kind was brought before them, and their opinion was invited, remarks made could not be called criticism if they were not to speak honestly of what they felt to be its merits or demerits, as the case might be. Mr. Mayall, their Secretary, had, on his part, a very extensive knowledge of the Microscopes which had been produced by the makers of the world. Mr. Nelson also, on his part, had a practical acquaintance both with the construction and the working of the instrument such as few other persons had the opportunity of possessing. He might also add that his own laboratory contained instruments by every maker of any reputation here or elsewhere, and he felt bound to say that this form of fine-adjustment was not satisfactory; indeed, for use with the highest powers it was most unsatisfactory. When they had a thread so fine as the 1/100 in., and placed upon it the whole weight of the body, the ultimate result could hardly be otherwise than as he had found it. When, as a defence, it was said that an arrangement which they had before them "did not interfere with rotation of the stage," it seemed as if it was time to inquire what was meant by rotation. Those who were engaged in special investigations knew quite well what they wanted, and the microscopist so employsd knew that he wanted to completely rotate, if need arose, the stage of the instrument he was using. His own feeling was that, when a Microscope of that kind was brought before them, there were only two courses open to them—either absolute silence, or absolute honesty, in the matter of criticism.

Mr. Grenfell exhibited a photograph, taken by Mr. Nelson, of a small organism found a short time ago, the nature of which he had been as yet unable to determine, some of the best zoologists and botanists to whom he had shown it being unable to say whether it was vegetable or animal in its nature. The whole of the details were brought out in such a way as to afford a striking instance of the value of photography for such purposes. He also wished to mention that at the present time in the Botanical Gardens (and, he also believed, in the boating-pond, Regent's Park) there were considerable numbers of a free-swimming infusorian known as *Tintinnus*, formerly described by Claparède. It was remarkable

for its chitinous lorica, a specimen of which he had brought for exhibition, the creature itself not being easy to exhibit, in consequence of its rapid movements. Claparède mentioned its having been found at Berlin; but hitherto it had only seemed to be found in sea-water.

Prof. Bell said they had received another communication from Mr. T. B. Rosseter, who had for some time been interesting himself in endeavouring to trace out the life-history of certain tape-worms. It would be remembered that some months ago he had sent a paper on the subject, but it was then shown that his observation had been anticipated. He had now sent a paper describing the development of *Tænia lanceolata* from the duck, the cysticercoid form of which had not been previously known. He appeared to have fed the ducks with some of the *Cypris* known to be infested with the parasite, and after some weeks opened the ducks and found the tape-worms mentioned. It was, of course, interesting to get the life-history of another tape-worm worked out.

Mr. T. B. Rosseter has prepared the following abstract:—He reports the discovery of a new *Cysticercus* which makes *Cypris cinerea* its intermediate host. The peculiarity of this *Cysticercus* consists in the fact that when evaginated from the cyst by the action of reagents the four suckers on the scolex are seen to be armed with from 180 to 200 very minute hooks; their measurement, individually, is 1/5000 in. from base of anterior root to tip of claw. These hooks are arranged around the periphery of the suckers and again longitudinally from the polar axis to the base of sucker in rows of three hooks in each row, and their position on the sucker is in reverse order to the hooks on the rostellum. The rostrum, which is invaginated in the cysticercus stage, bears ten hooks, each one measuring 1/600 in. Ducks when fed with this *Cysticercus* produce a tape-worm similar in every respect to the embryonic scolex in the cyst, even the minute hooks on the suckers existing in this stage of the life-history of the creature. This armature of the suckers is unique in the history of cysticercoids and Cestoida. The hooks on the rostellum, the rostrum itself, the elongated proboscis, scolex, and generative organs all correspond to the *Tænia lanceolata* of Goeze, Rudolphi, and Dujardin. No mention is made by any of these investigators of the existence of hooks on the suckers of this tape-worm. Such being the case, *Cysticercus* with ten hooks and armed suckers (Rosseter) equals *Tænia lanceolata* (Goeze, Rudolphi, Dujardin).

Mr. E. M. Nelson read a note on the subject of "Lateral Development in Photography," advanced by Mr. Pringle in his note printed in the Journal of the Society for April last, pp. 263–4. He had tried many experiments, leading to the conclusion that Mr. Pringle was wholly mistaken in supposing that the width of a flagellum is increased to an extent at least 50 per cent. by lateral development. If lateral development of this kind occurred, it would eat into the image of the flagellum on the negative, and so make it thinner than the image on the screen; but when the negative was printed this lateral development would act in the opposite direction, and if the actions were equal in extent the size of the flagellum would be restored to the original size of the image on the screen. In no case could the action of the lateral development on the

negative and on the print be cumulative. Mr. Nelson considered it highly important to dispose of the lateral development theory, for if such an error were allowed currency without challenge, it would very soon be said that a photomicrograph, on account of this lateral development, had no scientific value.

Mr. Nelson also read a short paper "On the Use of Monochromatic Light in Microscopy," and exhibited and described the model of a new and simple apparatus for obtaining the same by means of a glass prism.

Mr. Mayall said he recollected the original apparatus designed by the late M. Prazmowski at the time he was in partnership with Hartnack; it was troublesome to manage, so that not very much was done with it. That made by Zeiss, later on, was practically the same thing. He thought, however, that the apparatus before them was very likely to do good work, and the facility with which the prism could be turned, and the illumination varied from one end to the other of the spectrum, at once commended it to notice. He understood Mr. Nelson to say that by changing the monochromatic light from yellow to blue, the resolving power of the objective could be plainly seen to be augmented by an amount equivalent to ·1 N.A., and that in many cases an ordinary achromatic objective produced images as perfect as those given by apochromatic objectives. These were points of special scientific interest. He should not be satisfied, however, until Mr. Comber had seen it and put it through its paces, using sunlight, because now they were not content with mere performance with the Microscope, but they must have good photographic results as well. Of course, to be of permanent value, the apparatus must not be made of wood, as in the model. There would be no difficulty in adapting an inexpensive form of spectroscope for the purpose.

Mr. Nelson also described a new Projection Microscope fitted with a special condenser made of three flint lenses so as to embrace the whole cone of 82°. The only novelty about it was the system of collecting the light, by which a beam of $4\frac{1}{4}$ in. was brought down to one of $1\frac{1}{4}$ in., and by passing through the two lenses placed in a water-trough, a beam of parallel rays of great intensity was obtained for use in projecting the image upon the screen. It was necessary to have a different condenser for each objective, as the one must be perfectly adapted for use with the other. He had at present only two, one being for use with Zeiss's A A, equal to about an ordinary 1 in., and the other being a lower power. A number of slides were exhibited upon the screen.

The President said he had been very much struck with the beauty of the views which had been shown, and thought that it would be a great acquisition to any one who wanted to give exhibitions of microscopical objects. Very few schools should be unprovided with such an apparatus. He was sure those present felt greatly obliged to Mr. Nelson for what he had shown them.

Mr. Mayall said that some seven or eight years ago, when Dr. Hugo Schröder first came to England, he gave a description of a Microscope for projection purposes which he had devised, examples of which were

in use in Germany and in the United States. Figures of this instrument had been given in the Journal of the Society, and Mr. Crisp had been so much struck with the importance of having such an instrument for use at the Society's meetings, that it was decided to order one, and if it proved successful the Society would have been strongly advised to acquire one. Unfortunately, however, from various causes, the order had never been executed. The intention in Dr. Schröder's apparatus was much the same as that of Mr. Nelson, though the plan of the latter was much less ambitious and much less expensive. He thought Mr. Nelson was rendering valuable services to microscopy in working out these improved forms of condensers for projection apparatus. The images he had shown upon the screen were very clear, sharp, and luminous, comparing most favourably with the exhibition made some time ago at the Society by Mr. Lewis Wright. He might also say that Mr. Nelson's projection images were far superior to anything shown at the Crystal Palace and elsewhere, with Microscopes said to magnify 50,000 diameters. It was interesting to note the extent of sharp field given by objectives of different construction; the projection images enabled the observer to select different qualities of objectives with great facility. He hoped the Society's funds would soon enable them to acquire such an instrument for practical demonstrations in illustration of papers at the meetings—a point which Mr. Crisp and he had long regarded as worthy of the Society's most careful consideration. The possession of a projection lantern for exhibiting photographs, &c., on the screen was, of course, involved in the equipment required by the Society; but the projection Microscope itself, with which Microscope objectives could be employed effectively, was the essential thing required.

The President announced that the next meeting would take place on Wednesday, 17th June.

The following Instruments, Objects, &c., were exhibited:—

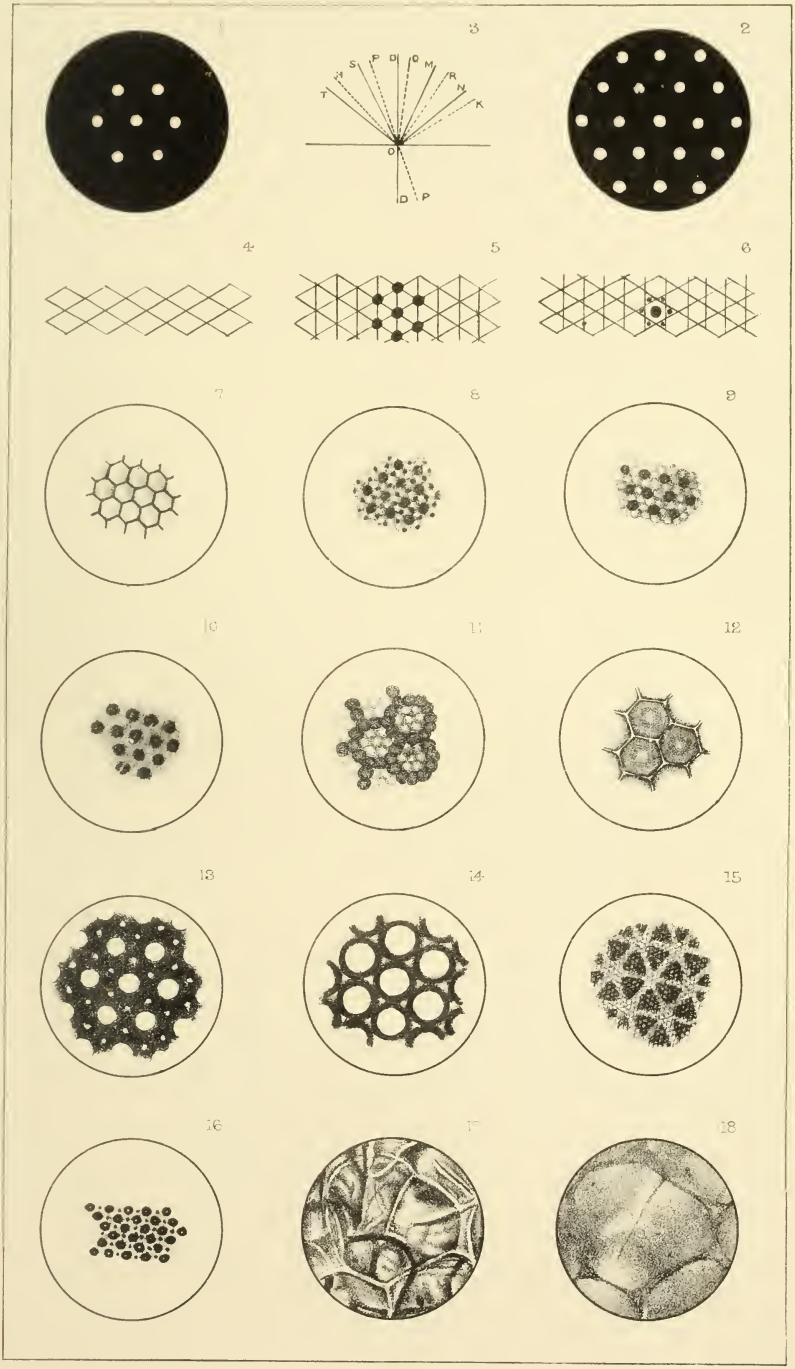
Mr. C. L. Curties:—Baker's Improved Student's Microscope, and Zeiss's Mechanical Stage (Mayall's form).

Mr. E. M. Nelson:—(1) Projection Microscope. (2) New Apparatus for producing Monochromatic Illumination for the Microscope.

Mr. T. B. Rosseter:—Slides (3) of *Cysticercus* in illustration of his note.

Messrs. W. Watson & Sons:—Dr. Van Heurck's Microscope for Photomicrography and high-power work.

New Fellows:—The following were elected *Ordinary* Fellows:—Mr. Samuel Hartshorne Ridge, B.A., F.R.G.S., and Sir Walter Joseph Sendall, K.C.M.G., Governor of Barbados.



E. M. Nelson photo

West, Newman
Horace Knight
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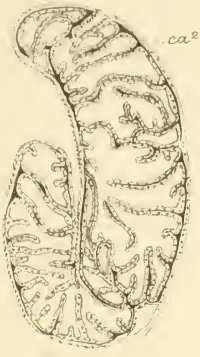

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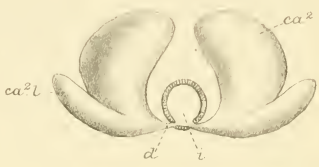

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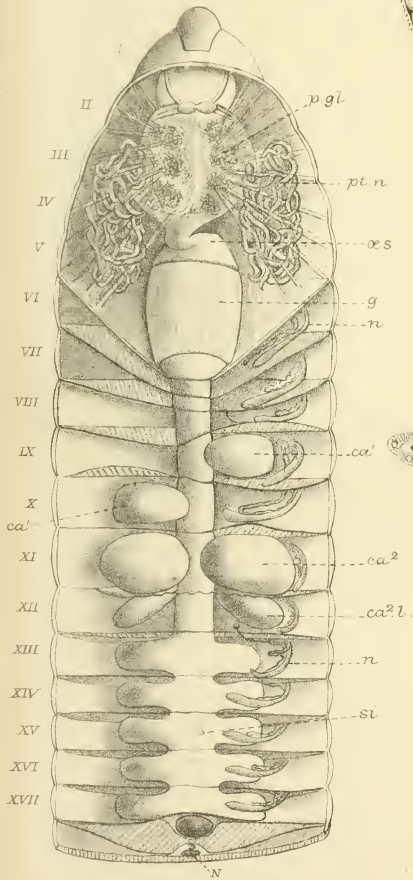

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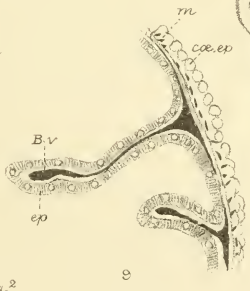

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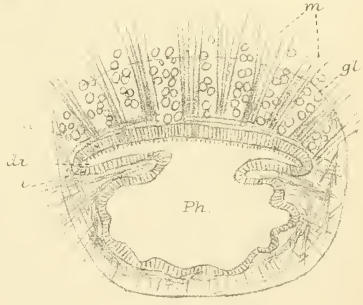

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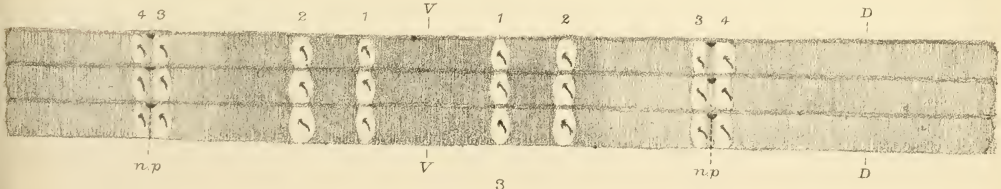

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W.B.B. del.

Eminia equatorialis.

West, Newman imp

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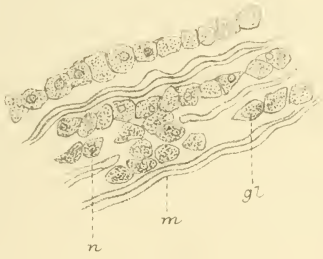

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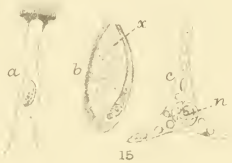

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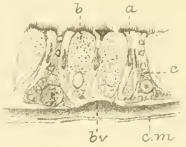

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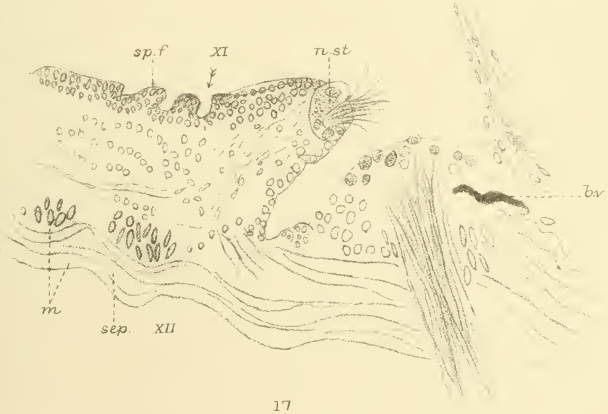

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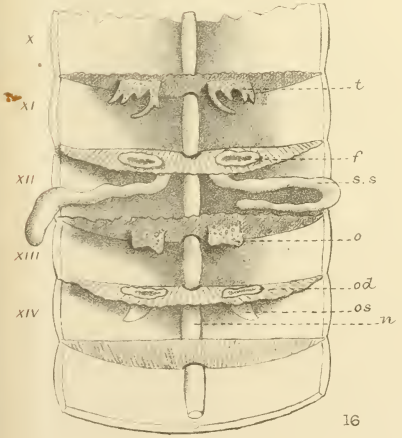

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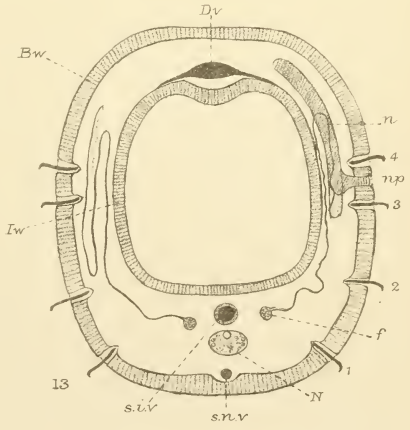

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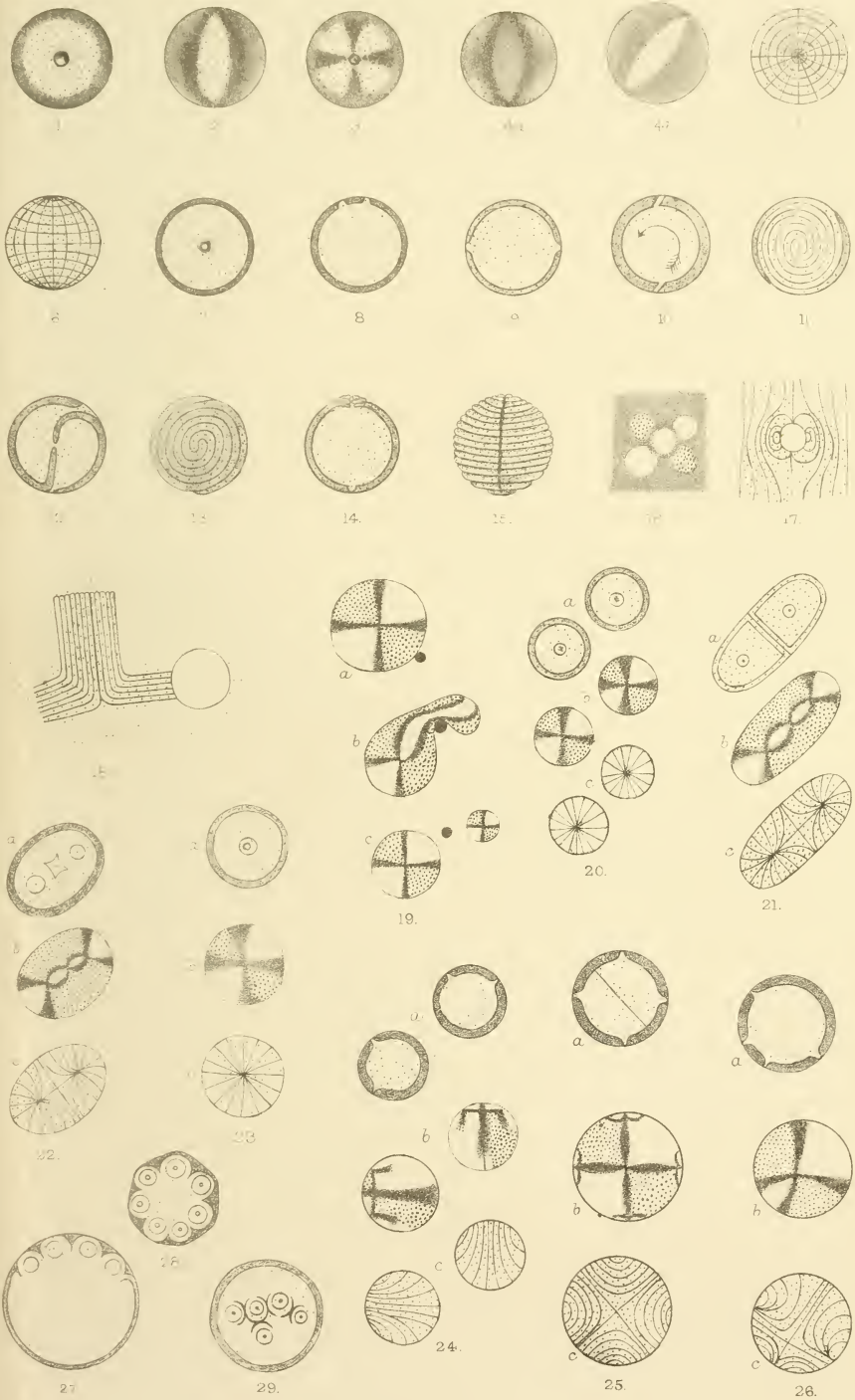
W.B.B. del.

West, Newman imp.

Eminia equatorialis.



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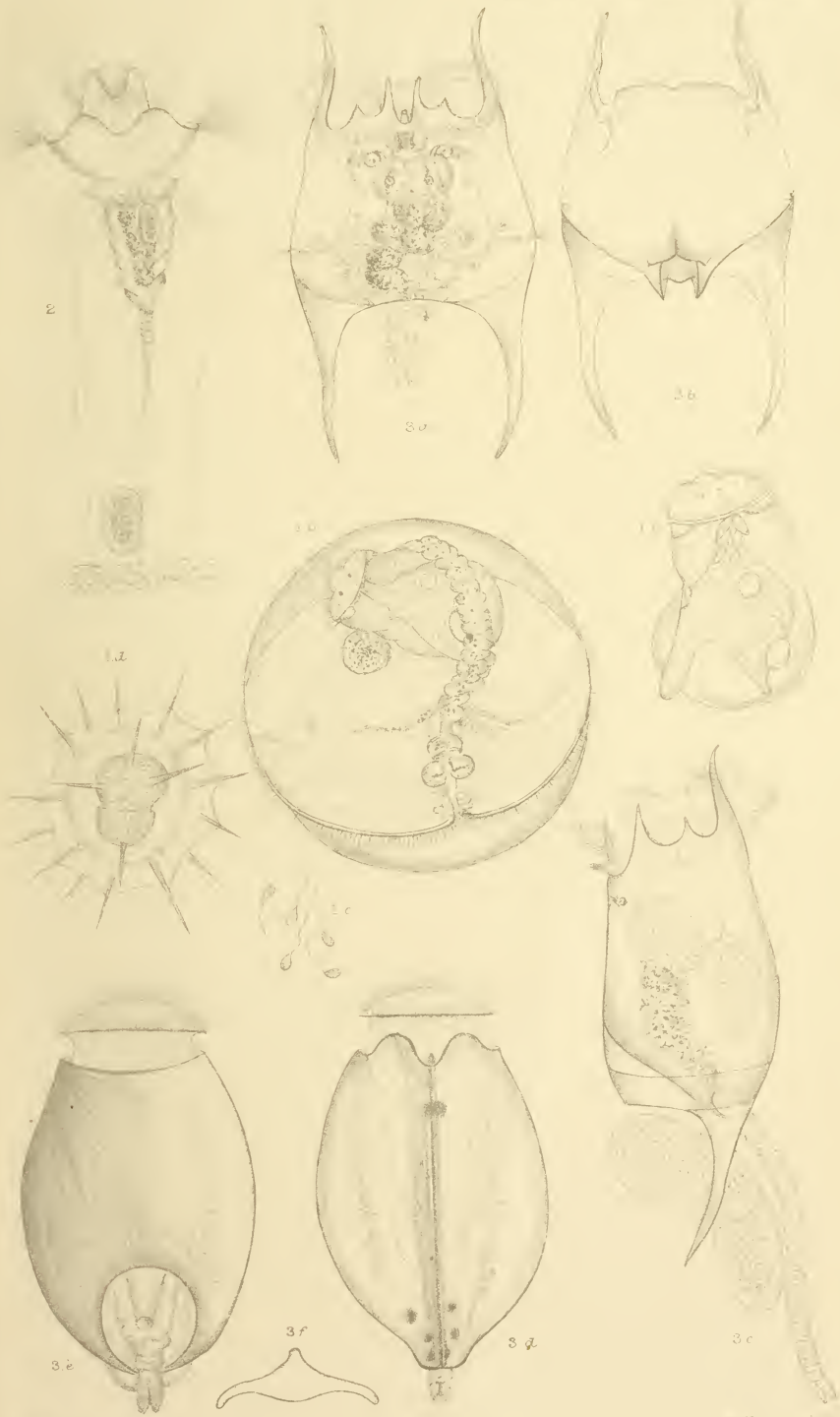
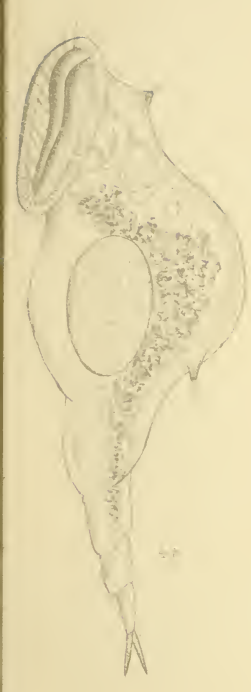
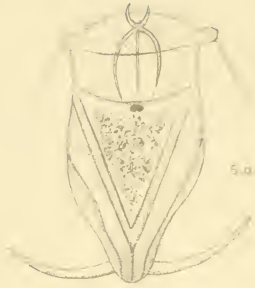
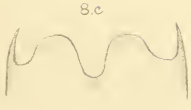
Liquid Crystals.

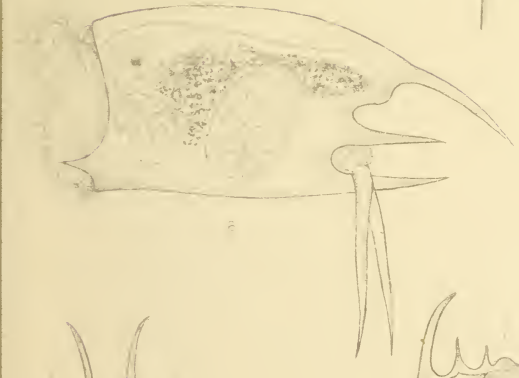


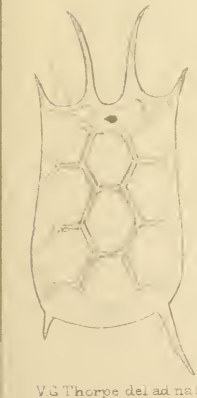
New and Foreign Rotifera.











V.G Thorpe del ad nat.

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