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

FRANK CRISP, LL.B., B.A.,

One of the Secretaries of the Society
and a Vice-President and Treasurer of the Linnean Society of London;

WITH THE ASSISTANCE OF THE PUBLICATION COMMITTEE AND

A. W. BENNETT, M.A., B.Sc., *Lecturer on Botany at St. Thomas's Hospital,*

F. JEFFREY BELL, M.A., *Professor of Comparative Anatomy in King's College*

S. O. RIDLEY, M.A., *of the British Museum,* JOHN MAYALL, JUN.,

AND FRANK E. BEDDARD, M.A.,

FELLOWS OF THE SOCIETY.

Ser. II.—VOL. IV. PART 2.

PUBLISHED FOR THE SOCIETY BY

WILLIAMS & NORGATE,

LONDON AND EDINBURGH.

1884.

Ser. 2
vol. 4
pts. 4-6

The Journal is issued on the second Wednesday of
February, April, June, August, October, and December.

Ser. II.
Vol. IV. Part 4. AUGUST, 1884. To Non-Fellows, Price 5s.

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

FRANK CRISP, LL.B., B.A.,

One of the Secretaries of the Society
and a Vice-President and Treasurer of the Linnean Society of London;

WITH THE ASSISTANCE OF THE PUBLICATION COMMITTEE AND

A. W. BENNETT, M.A., B.Sc., *Lecturer on Botany at St. Thomas's Hospital,*
F. JEFFREY BELL, M.A., *Professor of Comparative Anatomy in King's College,*
S. O. RIDLEY, M.A., *of the British Museum,* JOHN MAYALL, JUN.,
AND FRANK E. BEDDARD, M.A.,
FELLOWS OF THE SOCIETY.

WILLIAMS & NORGATE,
LONDON AND EDINBURGH.

CONTENTS.

SUMMARY OF CURRENT RESEARCHES, &c.—*continued.*

BOTANY.

SUMMARY OF CURRENT RESEARCHES, &c.—*continued*.

ROYAL MICROSCOPICAL SOCIETY.

COUNCIL.

ELECTED 13th FEBRUARY, 1884.

PRESIDENT.

Rev. W. H. Dallinger, F.R.S.

VICE-PRESIDENTS.

John Anthony, Esq., M.D., F.R.C.P.L.
Prof. P. Martin Duncan, M.B., F.R.S.
James Glaisher, Esq., F.R.S., F.R.A.S.
Charles Stewart, Esq., M.R.C.S., F.L.S.

TREASURER.

Lionel S. Beale, Esq., M.B., F.R.C.P., F.R.S.

SECRETARIES.

Frank Crisp, Esq., LL.B., B.A., V.P. & Treas. L.S.
Prof. F. Jeffrey Bell, M.A., F.Z.S.

Twelve other MEMBERS of COUNCIL.

Alfred William Bennett, Esq., M.A., B.Sc., F.L.S.
Robert Braithwaite, Esq., M.D., M.R.C.S., F.L.S.
G. F. Dowdeswell, Esq., M.A.
J. William Groves, Esq.
John E. Ingpen, Esq.
John Matthews, Esq., M.D.
John Mayall, Esq., Jun.
Albert D. Michael, Esq., F.L.S.
John Millar, Esq., L.R.C.P.Edin., F.L.S.
William Millar Ord, Esq., M.D., F.R.C.P.
Urban Pritchard, Esq., M.D.
William Thomas Suffolk, Esq.

LIBRARIAN and ASSISTANT SECRETARY.

Mr. James West.

I. Numerical Aperture Table.

The "APERTURE" of an optical instrument indicates its greater or less capacity for receiving rays from the object and transmitting them to the image, and the aperture of a Microscope objective is therefore determined by the ratio between its focal length and the diameter of the emergent pencil at the plane of its emergence—that is, the utilized diameter of a single-lens objective or of the back lens of a compound objective.

This ratio is expressed for all media and in all cases by $n \sin u$, n being the refractive index of the medium and u the semi-angle of aperture. The value of $n \sin u$ for any particular case is the "*numerical aperture*" of the objective.

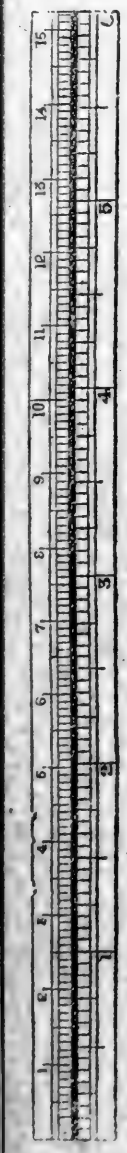
Diameters of the Back Lenses of various Dry and Immersion Objectives of the same Power ($\frac{1}{4}$ in.) from 0·50 to 1·52 N. A.	Numerical Aperture. ($n \sin u = a$.)	Angle of Aperture ($= 2u$).			Illuminating Power. (a^2.)	Theoretical Resolving Power, in Lines to an Inch. ($\lambda = 0{\cdot}5269\ \mu$ = line E.)	Penetrating Power. $\left(\frac{1}{a}\right)$
		Dry Objectives. ($n = 1$.)	*Water-Immersion* Objectives. ($n = 1{\cdot}33$.)	*Homogeneous-Immersion* Objectives. ($n = 1{\cdot}52$.)			
1·52	1·52	..	..	180° 0′	2·310	146,528	·658
	1·50	..	..	161° 23′	2·250	144,600	·667
	1·48	..	..	153° 39′	2·190	142,672	·676
	1·46	..	..	147° 42′	2·132	140,744	·685
	1·44	..	..	142° 40′	2·074	138,816	·694
	1·42	..	..	138° 12′	2·016	136,888	·704
	1·40	..	..	134° 10′	1·960	134,960	·714
	1·38	..	..	130° 26′	1·904	133,032	·725
	1·36	..	..	126° 57′	1·850	131,104	·735
	1·34	..	..	123° 40′	1·796	129,176	·746
1·33	1·33	..	180° 0′	122° 6′	1·770	128,212	·752
	1·32	..	165° 56′	120° 33	1·742	127,248	·758
	1·30	..	155° 38′	117° 34′	1·690	125,320	·769
	1·28	..	148° 28′	114° 44′	1·638	123,392	·781
	1·26	..	142° 39′	111° 59′	1·588	121,464	·794
	1·24	..	137° 36′	109° 20′	1·538	119,536	·806
	1·22	..	133° 4′	106° 45′	1·488	117,608	·820
	1·20	..	128° 55′	104° 15′	1·440	115,680	·833
1·16	1·18	..	125° 3′	101° 50′	1·392	113,752	·847
	1·16	..	121° 26′	99° 29′	1·346	111,824	·862
	1·14	..	118° 00′	97° 11′	1·300	109,896	·877
	1·12	..	114° 44′	94° 56′	1·254	107,968	·893
	1·10	..	111° 36′	92° 43′	1·210	106,040	·909
1·0	1·08	..	108° 36′	90° 33′	1·166	104,112	·926
	1·06	..	105° 42′	88° 26′	1·124	102,184	·943
	1·04	..	102° 53′	86° 21′	1·082	100,256	·962
	1·02	..	100° 10′	84° 18′	1·040	98,328	·980
	1·00	180° 0′	97° 31′	82° 17′	1·000	96,400	1·000
	0·98	157° 2′	94° 56′	80° 17′	·960	94,472	1·020
	0·96	147° 29′	92° 24′	78° 20′	·922	92,544	1·042
·90	0·94	140° 6′	89° 56′	76° 24′	·884	90,616	1·064
	0·92	133° 51′	87° 32′	74° 30′	·846	88,688	1·087
	0·90	128° 19′	85° 10′	72° 36′	·810	86,760	1·111
	0·88	123° 17′	82° 51′	70° 44′	·774	84,832	1·136
	0·86	118° 38′	80° 34′	68° 54′	·740	82,904	1·163
	0·84	114° 17′	78° 20′	67° 6′	·706	80,976	1·190
·80	0·82	110° 10′	76° 8′	65° 18′	·672	79,048	1·220
	0·80	106° 16′	73° 58′	63° 31′	·640	77,120	1·250
	0·78	102° 31′	71° 49′	61° 45′	·608	75,192	1·282
	0·76	98° 56′	69° 42′	60° 0′	·578	73,264	1·316
	0·74	95° 28′	67° 36′	58° 16′	·548	71,336	1·351
·70	0·72	92° 6′	65° 32′	56° 32′	·518	69,408	1·389
	0·70	88° 51′	63° 31′	54° 50′	·490	67,480	1·429
	0·68	85° 41′	61° 30′	53° 9′	·462	65,552	1·471
	0·66	82° 36′	59° 30′	51° 28′	·436	63,624	1·515
	0·64	79° 35′	57° 31′	49° 48′	·410	61,696	1·562
·60	0·62	76° 38′	55° 34′	48° 9′	·384	59,768	1·613
	0·60	73° 44′	53° 38′	46° 30′	·360	57,840	1·667
	0·58	70° 54′	51° 42′	44° 51′	336	55,912	1·724
	0·56	68° 6′	49° 48′	43° 14′	·314	53,984	1·786
	0·54	65° 22′	47° 54′	41° 37′	·292	52,056	1·852
·50	0·52	62° 40′	46° 2′	40° 0′	·270	50,128	1·923
	0·50	60° 0′	44° 10′	38° 24′	·250	48,200	2·000

EXAMPLE.—The apertures of four objectives, two of which are dry, one water-immersion, and one oil-immersion, would be compared on the *angular* aperture view as follows:—166° (air), 157° (air), 142° (water), 130° (oil).
Their actual apertures are, however, as ·80 ·98 1·26 1·38 or their numerical apertures.

II. Conversion of British and Metric Measures.

(1.) Lineal.

Scale showing the relation of Millimetres, &c., to Inches.



1000 μ = 1 mm.
10 mm. = 1 cm.
10 cm. = 1 dm.
10 dm. = 1 metre.

Micromillimetres, &c., into Inches, &c.

μ	ins.	mm.	ins.	mm.	ins.
1	·000039	1	·039370	51	2·007892
2	·000079	2	·078741	52	2·047262
3	·000118	3	·118111	53	2·086633
4	·000157	4	·157482	54	2·126003
5	·000197	5	·196852	55	2·165374
6	·000236	6	·236223	56	2·204744
7	·000276	7	·275593	57	2·244115
8	·000315	8	·314963	58	2·283485
9	·000354	9	·354334	59	2·322855
10	·000394	10 (1 cm.)	·393704	60 (6 cm.)	2·362226
11	·000433	11	·433075	61	2·401596
12	·000472	12	·472445	62	2·440967
13	·000512	13	·511816	63	2·480337
14	·000551	14	551186	64	2·519708
15	·000591	15	·590556	65	2·559078
16	·000630	16	·629927	66	2·598449
17	·000669	17	·669297	67	2·637819
18	·000709	18	·708668	68	2·677189
19	·000748	19	·748038	69	2·716560
20	·000787	20 (2 cm.)	·787409	70 (7 cm.)	2·755930
21	·000827	21	·826779	71	2·795301
22	·000866	22	·866150	72	2·834671
23	·000906	23	·905520	73	2·874042
24	·000945	24	·944890	74	2·913412
25	·000984	25	·984261	75	2·952782
26	·001024	26	1·023631	76	2·992153
27	·001063	27	1·063002	77	3·031523
28	·001102	28	1·102372	78	3·070894
29	·001142	29	1·141743	79	3·110264
30	·001181	30 (3 cm.)	1·181113	80 (8 cm.)	3·149635
31	·001220	31	1·220483	81	3·189005
32	·001260	32	1·259854	82	3·228375
33	·001299	33	1·299224	83	3·267746
34	·001339	34	1·338595	84	3·307116
35	·001378	35	1·377965	85	3·346487
36	·001417	36	1·417336	86	3·385857
37	·001457	37	1·456706	87	3·425228
38	·001496	38	1·496076	88	3·464598
39	·001535	39	1·535447	89	3·503968
40	·001575	40 (4 cm.)	1·574817	90 (9 cm.)	3·543339
41	·001614	41	1·614188	91	3·582709
42	·001654	42	1·653558	92	3·622080
43	·001693	43	1·692929	93	3·661450
44	·001732	44	1·732299	94	3·700820
45	·001772	45	1·771669	95	3·740191
46	·001811	46	1·811040	96	3·779561
47	·001850	47	1·850410	97	3·818932
48	·001890	48	1·889781	98	3·858302
49	·001929	49	1·929151	99	3·897673
50	·001969	50 (5 cm.)	1·968522	100 (10 cm. = 1 decim.)	
60	·002362				
70	·002756				
80	·003150				
90	·003543				
100	·003937				
200	·007874				
300	·011811				
400	·015748				
500	·019685				
600	·023622				
700	·027559				
800	·031496				
900	·035433				
1000 (= 1 mm.)					

decim.	ins.
1	3·937043
2	7·874086
3	11·811130
4	15·748173
5	19·685216
6	23·622259
7	27·559302
8	31·496346
9	35·433389
10 (1 metre)	39·370432
=	3·280869 ft.
=	1·093623 yds.

Inches, &c., into Micromillimetres, &c.

ins.	μ
$\frac{1}{25000}$	1·015991
$\frac{1}{20000}$	1·269989
$\frac{1}{15000}$	1·693318
$\frac{1}{10000}$	2·539977
$\frac{1}{9000}$	2·822197
$\frac{1}{8000}$	3·174972
$\frac{1}{7000}$	3·628539
$\frac{1}{6000}$	4·233295
$\frac{1}{5000}$	5·079954
$\frac{1}{4000}$	6·349943
$\frac{1}{3000}$	8·466591
$\frac{1}{2000}$	12·699886
$\frac{1}{1000}$	25·399772
	mm.
$\frac{1}{900}$	·028222
$\frac{1}{800}$	·031750
$\frac{1}{700}$	·036285
$\frac{1}{600}$	·042333
$\frac{1}{500}$	·050800
$\frac{1}{450}$	·056444
$\frac{1}{400}$	·063499
$\frac{1}{350}$	·072571
$\frac{1}{300}$	·084666
$\frac{1}{250}$	·101599
$\frac{1}{200}$	·126999
$\frac{1}{150}$	·169332
$\frac{1}{100}$	·253998
$\frac{1}{50}$	·507995
$\frac{1}{25}$	1·015991
$\frac{1}{20}$	1·269989
$\frac{1}{16}$	1·587486
$\frac{1}{15}$	1·693318
$\frac{1}{12}$	2·116648
$\frac{1}{10}$	2·539977
$\frac{1}{8}$	3·174972
$\frac{1}{6}$	4·233295
$\frac{3}{16}$	4·762457
$\frac{1}{5}$	5·079954
$\frac{1}{4}$	6·349943
$\frac{5}{16}$	7·937429
$\frac{3}{8}$	9·524915
	cm.
$\frac{7}{16}$	1·111240
$\frac{1}{2}$	1·269989
$\frac{9}{16}$	1·428737
$\frac{5}{8}$	1·587486
$\frac{11}{16}$	1·746234
$\frac{3}{4}$	1·904983
$\frac{13}{16}$	2·063732
$\frac{7}{8}$	2·222480
$\frac{15}{16}$	2·381229
1	2·539977
2	5·079954
3	7·619932
	decim.
4	1·015991
5	1·269989
6	1·523986
7	1·777984
8	2·031982
9	2·285979
10	2·539977
11	2·793975
1 ft.	3·047973
	metres.
1 yd. =	·914392

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

FRANK CRISP, LL.B., B.A.,

one of the Secretaries of the Society and a Vice-President and Treasurer of the Linnean Society of London;

WITH THE ASSISTANCE OF THE PUBLICATION COMMITTEE AND

A. W. BENNETT, M.A., B.Sc., Lecturer on Botany at St. Thomas's Hospital,

F. JEFFREY BELL, M.A., Professor of Comparative Anatomy in King's College,

S. O. RIDLEY, M.A., of the British Museum, JOHN MAYALL, Jun., and FRANK E. BEDDARD, M.A.

FELLOWS OF THE SOCIETY.

THIS Journal is published bi-monthly, on the second Wednesday of the months of February, April, June, August, October, and December. It varies in size, according to convenience, but does not contain less than 9 sheets (144 pp.) with Plates and Woodcuts as required. The price to non-Fellows is 5*s.* per Number.

The Journal comprises:

(1.) The TRANSACTIONS and the PROCEEDINGS of the Society: being the Papers read and Reports of the business transacted at the Meetings of the Society, including any observations or discussions on the subjects brought forward.

(2.) SUMMARY of CURRENT RESEARCHES relating to ZOOLOGY and BOTANY (principally Invertebrata and Cryptogamia, with the Embryology and Histology of the higher Animals and Plants), and MICROSCOPY (properly so called): being abstracts of or extracts from the more important of the articles relating to the above subjects contained in the various British and Foreign Journals, Transactions, &c., from time to time added to the Library.

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 12*s.* 6*d.* per half-sheet of 8 pages, or less, including cover, for a minimum number of 100 copies, and 6*s.* per 100 plates, if plain. Prepayment by P.O.O. is requested.

All communications as to the Journal should be addressed to the Editor, Royal Microscopical Society, King's College, Strand, W.C.

Published for the Society by

WILLIAMS AND NORGATE,

LONDON AND EDINBURGH.

MICROSCOPICAL SOCIETY'S TRANSACTIONS (3 vols., half-calf); QUARTERLY JOURNAL OF MICROSCOPICAL SCIENCE (16 vols., half-morocco); and MONTHLY MICROSCOPICAL JOURNAL (18 vols., half-calf) for SALE. Price £20.

Apply to Mr. J. WEST, at the Society's Library.

ROYAL MICROSCOPICAL SOCIETY.

MEETINGS FOR 1884, at 8 p.m.

Wednesday, JANUARY	9	Wednesday, MAY	14
„ FEBRUARY	13	„ JUNE	11
(Annual Meeting for Election of Officers and Council.)		„ OCTOBER	8
„ MARCH	12	„ NOVEMBER	12
„ APRIL	9	„ DECEMBER	10

THE "SOCIETY" STANDARD SCREW.

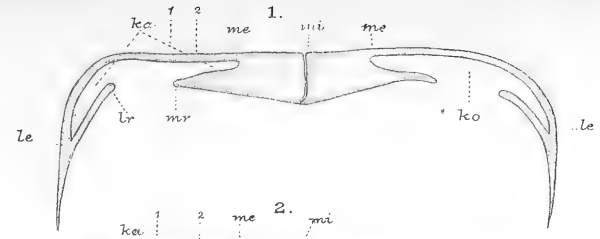
The Council have made arrangements for a further supply of Gauges and Screw-tools for the "SOCIETY" STANDARD SCREW for OBJECTIVES.

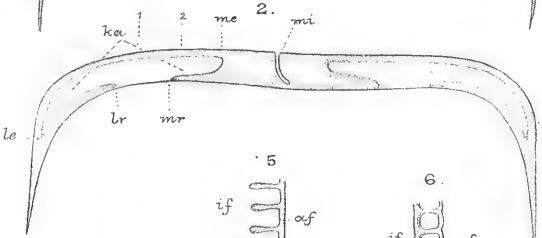
The price of the set (consisting of Gauge and pair of Screw-tools) is 12*s.* 6*d.* (post free 12*s.* 10*d.*). Applications for sets should be made to the Assistant-Secretary.

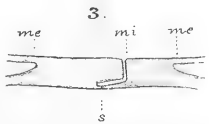
For an explanation of the intended use of the gauge, see Journal of the Society, I. (1881) pp. 548–9.

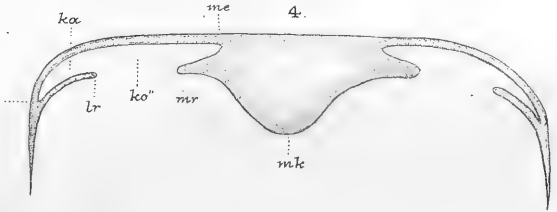
ADVERTISEMENTS FOR THE JOURNAL.

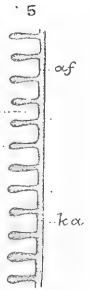
Mr. CHARLES BLENCOWE, of 75, Chancery Lane, W.C., is the authorized Agent and Collector for Advertising Accounts on behalf of the Society.

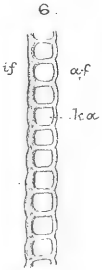


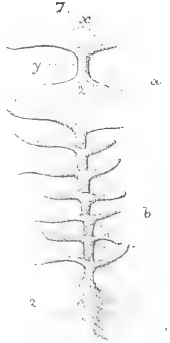


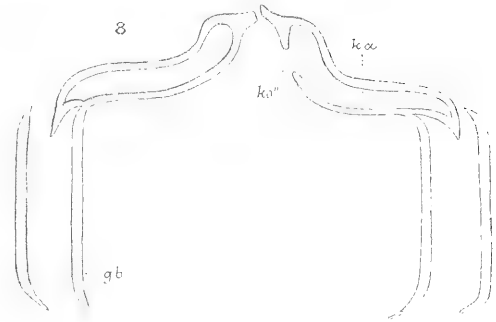


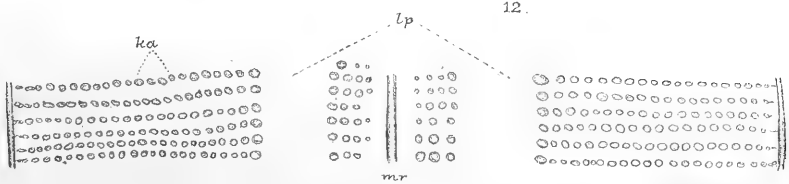








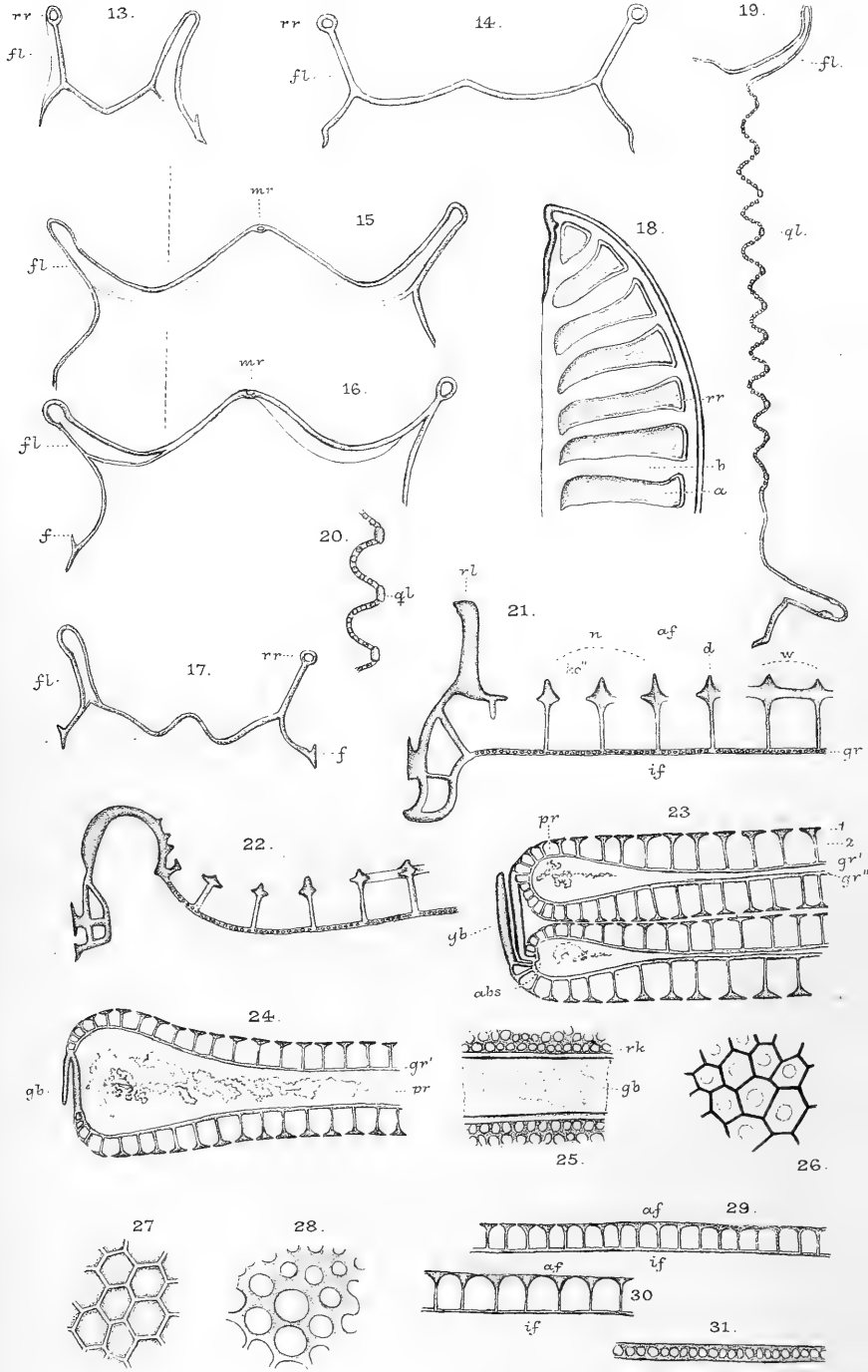




J.H.L. Flögel del.

Pinnularia & Navicula.

West Newman & Co. imp.



J.H.L. Flögel del.

West, Newman & Co lith.

Surirella Triceratium & Coscinodiscus.

JOURNAL
OF THE
ROYAL MICROSCOPICAL SOCIETY.
AUGUST 1884.

TRANSACTIONS OF THE SOCIETY.

XI.—*Researches on the Structure of the Cell-walls of Diatoms.**

By Dr. J. H. L. Flögel.

(*Read 12th December*, 1883.)

Plates VIII. and IX.

The various objections made to my previous researches have induced me to undertake a re-investigation, and although this has for the most part been simply corroborative, it has appeared to me desirable to publish the results, together with some obtained in reference to other diatoms of which only preliminary communications (7) have hitherto been published.

Day by day the old erroneous views on the structure of diatoms are repeated in the text-books of Botany, and nobody seems to have approached the subject seriously; the present paper may therefore, I hope, arouse sufficient interest to induce further investigation.

I. Method of Investigation.

I have already (6) described the methods which I have followed in the investigation of *Pleurosigma*; but it is necessary to refer here to the method of section-cutting. In applying my greater experience to *Pleurosigma* and other diatoms I have obtained generally much better results than formerly, which have lent additional confirmation to my paper of 1870.

Time of making Sections.—Accidentally I made my original investigations during the summer. When in the winter I wanted to replace some preparations, I found it impossible to obtain successful results. The cause was the artificially heated room. It is useless to attempt to bring the gum to the right degree of hardness by the addition of glycerin, sugar, &c., as, in consequence of the

* The original paper is written in German, and has been translated by Mr. J. Mayall, jun.

proximity of the face and the hands, the aqueous contents of such strongly hygroscopic substances are subject to an uncontrollable change, so that we must work with pure gum arabic and in the summer.

Slight differences are caused by the weather or by the position of the sun. Sections of the coarser diatoms which are not required to be of extreme thinness are best made with a clouded sky or in rainy weather. Sections of *Pleurosigma* succeed best when the sun shines directly into the laboratory without striking upon the Microscope. I can hardly too strongly dwell upon the necessity of entering upon such experimental investigations under the best physical conditions, absence of vibration, noise, &c.

Placing the Frustule.—By my earlier method sections in different directions were obtained hap-hazard because the frustules were lying pell-mell in the gum. I have now improved the method as follows:—I take a number of frustules like a bundle of rods and cut sections in the exact transverse or longitudinal direction. With this important but difficult method every one must become familiar if he intends to check the results (hereafter described) which I obtained with *Pinnularia.*

(1) If we wish to examine uninjured specimens, the diatoms are first stained, usually by picro-carmine; they are then put in absolute alcohol. A glass slip is coated with collodion, and allowed to set. To avoid peeling when dry, the collodion must not be too thick. A drop of thick gum is then put on. A cluster of diatoms is taken direct from the alcohol with forceps and placed in the gum. In consequence of the current set up, the diatoms immediately distribute themselves equally through the gum. As soon as the edge of the gum begins to harden, one frustule after the other is drawn to the edge by a very fine needle, where, with proper manipulation, they can be piled up like a bundle of rods. All those which interfere with this piling up should be removed. Owing to the staining, the frustules can be readily seen on the transparent ground. As soon as the edge dries, a drop of fluid gum is added by a needle, and this process is repeated until the solid layer of gum has reached such a thickness that a displacement of the frustules need be no longer feared; a small patch of collodion is then put on. The preparation is now cut out by four cross-cuts and carefully removed from the glass; the bundle of diatoms in gum being contained between two films of collodion. It is advisable to make a drawing with a high power to show the position of the individual frustules and aid in the identification of the sections. The preparation is then put upon a nearly dry flat drop of gum on a piece of cardboard, and the base and the edges are made to adhere, if necessary, by a few drops of water, and by the addition of minute drops of gum it is so imbedded that at last it is entirely surrounded. This must be carried

out so cautiously that the collodion films do not separate; very careful watching of the imbedding process is therefore necessary, especially also to avoid cracks which commence at the edge and might easily extend to the object. From this bundle, sections may be made according to the method described by me in 1870.

(2) Any one wishing to study the structure of the individual valves and mark their manner of combination can shorten this somewhat detailed process. A cluster of diatom valves is taken out of the alcohol and placed in a large drop of water on a slide; and the water is allowed to evaporate after the valves have been evenly distributed. A drop of gum already dry—if possible with a flat surface on a piece of cardboard—should be in readiness; another piece of glass is coated with oil of turpentine, which is allowed to run off so that a very thin film is left, which does not readily dry. In this the point of a fine needle is dipped vertically, taking up sufficient oil so that by touching a frustule lying on another slide it will adhere. Thus the frustule can be put on the hardened drop of gum which has been moistened by the breath; this is repeated with a number of valves *ad libitum*, and finally they are covered with minute drops of gum till the required thickness is attained. This transference of dry frustules upon the dry gum is much easier than the process with fluid gum described under (1), because, with the latter, it frequently occurs that in bringing a new frustule into place the others are disturbed. With uninjured frustules process (2) is not available, because these, after the drying of the thin upper layer of gum moistened with the breath, will at once become charged with air and baffle any cutting. This absorption of air can only be avoided by transferring the frustules from the alcohol directly into the fluid gum, which then diffuses equally through them. At the most the frustule at the moment of hardening is slightly compressed, which injures somewhat the appearance of the sections.

Making Sections.—Numerous attempts to cut diatoms on the microtome failed, and I always returned to cutting by hand, under a dissecting Microscope. Gum is not favourable as the imbedding medium for the microtome. If a better medium were discovered (paraffin is useless), then a new era would open for these researches. Knives with broad backs should be employed; the angles of inclination to the cutting edge I have used are 21° 20′.

Piling-up of the Sections.—Pfitzer (19, p. 42) formerly proposed to moisten by the breath the gum-chips containing the diatom sections after they had been put upon the slide, whereby they naturally adhered. Anything more unpractical cannot be imagined; the very thing one wishes to avoid—namely, the disturbance of the sections—is by his method certain to occur, and in the most favourable case we have a hardened drop of gum in

which are scattered all sorts of fragments of the diatom sections, which the observer may be able to define with reference to their previous position, but which are utterly useless for the study of real details of structure. The unavoidable proximity of finger and face during the cutting is injurious, because the immediate surrounding atmosphere of the operator always contains a quantity of moisture which causes the delicate chips of gum immediately to adhere. In piling-up the sections we should most carefully avoid every increase of moisture, and during the operation the breathing should be suppressed. If after discharging the sections from the knife we do not intend to put on the cover-glass at once, then the slide with the chips should only be lifted up when in sunlight and under protection from dust. As a rule, time should not here be lost. It is advisable before putting on the cover-glass to touch two corners, which first come in contact with the slide, with small drops of balsam, so that during the lowering of the cover-glass it does not slip out of place and so grind up the very brittle chips of gum. The lowering of the cover-glass should be done slowly and steadily. If let fall, the puff of air will blow away the chips. If the chips, on account of too little moisture in the atmosphere, are curled up, the cover-glass will flatten them out, the gum on the edges may split, but the centre becomes flat and is often very useful. In general, however, it is recommended, on the days when these difficulties occur, to postpone the operation. Once for all, I state that flat sections are always the most instructive. After putting on the cover-glass a proportionately small drop of thin fluid-balsam is added on the edge—only so much that the sections are imbedded in it. After a few days the vacant spaces are filled up by fresh drops of balsam; a derangement of the previously filled-up sections is no longer to be feared.

Series Preparations.—With *Pinnularia* the making of series sections is almost a necessity, especially for the longitudinal sections. My procedure is as follows, though I am well aware it is capable of improvement. I cut off No. 1, leaving it on the edge of the razor; then I take a second section a little further off, and so on, until five are on the edge. These I transfer to the slide with a needle, and as nearly as possible in a straight line. This is repeated with the other five sections which form the second line. Then I take a new slide, and thus get decades of sections from a bundle previously prepared. A disadvantage is that sometimes the sections do not remain on the edge; by falling upon the table they are lost. Also that not seldom one cuts a gum-chip as a numbered section, which on further examination proves never to have touched the bundle of frustules. By disregarding these very troublesome mishaps, the series-section method according to my view gives the most beautiful results obtainable with such

delicate objects. As an example, I may mention a bundle of *P. balticum* in my possession in 150 sections, of which 100 were successful; of these about 70 could be identified as being from one frustule.

Preservation of Preparations.—This subject is unfortunately for me at the present moment one of the most troublesome. One would anticipate that by taking quite dry gum imbedded in balsam slowly hardened, the preparation would be almost indestructible. I regret to say this is not always the case. My preparations of 1869 remained stable six to seven years. But afterwards a fatal change took place with many. The sharp straight edges of the gum-chips lost their sharpness, the edges rounded off, and lastly a kind of oil-drop took their place, in which the former beautiful sections almost disappeared. Whether my present house is too damp, or whether moisture works through the balsam along the glass up to the sections, I do not know; but I suspect something of the kind. The serials I made last June and July have kept *in partibus* well up to the present, but a portion commenced in October to change, although as a protection I had covered the edges with asphalt and kept them in a room which was warmed every day. The real cause of the destruction of these preparations is still a mystery, and I would recommend that sections should be studied immediately after being made.

II. Results of the Investigations.

My first paper was confined to the varieties of *Pleurosigma*, and I now give an account of all the other diatoms the structural details of which I have investigated. I may at once say that a general sketch of diatom sculpture cannot be given. We cannot take the structure discovered by me in *Pleurosigma* (consisting of chamber-like holes in the interior of the cell-membrane) and thus explain the structure of all diatoms, nor can we conclude from Möller's proved structure of *Triceratium* (viz. chambers open externally) that this is the same, *mutatis mutandis*, with all others of this numerous order.

1. *Pinnularia.*

Probably the cellular envelope of a great number of diatoms follows the type of *Pinnularia*, which may therefore be put first, all the more so since the views regarding their structure (chiefly based on Pfitzer) adopted in most text-books, are totally erroneous. Moreover, the structure of their cell-walls is very remarkable. For my material (*Pinnularia major*) I have again to thank Herr J. D. Möller. It consisted principally of isolated valves which were

treated by different methods, viz. (1) by the section method, (2) the cast method, (3) the staining method.

§ 1. I commence with the section method, remarking that most of my sections were made as described under (2). It is requisite that investigators should keep strictly to this method, otherwise they will not see the details of structure here described, or they will obtain from oblique sections images very difficult to interpret. We require very thin (e. g. 1/1000 mm.),* exactly transverse and longitudinal sections, whilst with *Pleurosigma* it does not matter if the direction of the cut deviates more or less from a right angle to the midrib. The transverse section of a valve of *Pinnularia*, if it has not touched the central nodule, has either the form of fig. 1 or fig. 2, plate VIII., except that in close proximity to the two ends the general form, by the disappearance of the rounded-off right angle, becomes semi-circular or semi-elliptical. In order to elucidate the change in the appearance of the inner structure we must remember that the surface image of *Pinnularia* exhibits coarse transverse striæ, ending near the midrib, and which are regarded by Pfitzer and others as superficial furrows, and they have therefore been designated by various improper terms, such as furrows, surface sculpture, &c. In reality the outer surface, independently of the midrib, has neither elevations nor depressions, but is quite plane. If the section passes through the middle of a so-called furrow, it appears as in fig. 1; if it passes through the interspace, then it appears as in fig. 2. The separate parts of the image are, as will be shown later on, to be explained as follows:—Each so-called furrow is an inner chamber of the membrane, and, in proportion to the chambers of *Pleurosigma*, of enormous size, since it extends from the edge of the frustule to very near the midrib. It is also of almost equal thickness throughout. But what is most remarkable is the fact that each chamber has a rather broad opening on the inner side of the cell-wall, by which it can be readily examined. The outlines of the opening are easily observed in the surface view, and have been often represented in the better class of illustrations (*vide* Pfitzer, 19, pl. 1, fig. 2). The draughtsmen, however, do not seem to have had a clear conception of the signification of these lines. *Pinnularia* is represented as a definite proof that the cell-envelope is broken through in the midrib, thereby allowing free exit to the protoplasm. All former reliable researches having apparently proved the non-existence of openings, and the endosmotic process having been generally accepted as the cause of movement (*vide* Naegeli, Von Siebold, W. Smith, Rabenhorst), Prof. Max Schultze (24) in 1865 put forward the opposite view and considered it proved that at the raphe of the

* Sections as made by Pfitzer (19, p. 43) which are twice or thrice the thickness of a furrow, cannot, as a matter of course, be used for a delicate observation. At the best one recognizes only the general outline.

diatoms there was a glutinous organic substance which could only be protoplasm. In 1870, Prof. Dippel's work (3) appeared refuting Schultze's view, and drawing attention to the fact that the midrib is not a cleft but rather a thickened line, having on the sides narrow longitudinal striæ without perforations.* Then came Pfitzer's work (19), who discovered the long-searched-for cleft and represented it so well that its existence is no longer doubted. He declares the detection of this cleft to be a task to be solved only with the highest powers, and draws a figure of a very narrow V-shaped opening through the thick envelope. Under existing circumstances it was of great interest to test Pfitzer's statements. The conclusion I came to was to agree entirely, without reserve, with Dippel, and I must therefore deny the perforation of the cell-wall. This result cannot, however, be easily obtained. The number of more or less good transverse sections of *Pinnularia* I have is about 600; in most of them I actually observed in the midrib a fine transverse cleft. Its direction and its fineness are shown in figs. 1–3. They can be well seen with 300–400 where the section is good. With regard to direction I rarely see the cleft so V-shaped as drawn by Pfitzer; on the contrary, in most instances it commences on the outer surface at right angles to it. Then arise a great variety of changes in the appearance. We meet with sections in which it goes straight to the inner surface; others where the vertical portion has a small hook turned inwards; again, others where the portion facing the inner surface is obtuse to the vertical,—this case (not at all uncommon) is represented in fig. 3. Such a change may be explained by a real difference in the object, which Schumann also quite correctly found with the surface view (23, p. 73). A careful comparison of a great number of transverse sections, made according to method 2, will show in most cases the cleft going up to the inner side of the membrane. The question remains very doubtful whether the base is closed by a very thin envelope. After having made collodion casts, the image of the outer surface could be easily interpreted; the fine cleft became filled with collodion, and in hardening a distinct midrib remains, almost exactly the same image as we see in the surface view. But the inner surface remained quite obscure. If a perforation of the membrane really exists, a similar midrib should be seen; but this is not the case. I have made a considerable number of such impressions, and not the slightest trace of a midrib could be seen, even with oblique light.

These impressions fully convinced me that the fine cleft was closed at the base. That the transverse sections mostly show a fully developed perforation may be attributed to the following

* This is what I proved simultaneously with *Pleurosigma* (striæ without spores).

cause:—In transferring a frustule to the gum it may, of course, be done according to method 2 without injury, but not always. In further experimenting the mass, in hardening, may suffer unequal pressure on the valves, causing them to break, as also stated by Pfitzer (19, p. 50), and this is very likely to occur in the midrib. In this case they were injured before cutting. It is, however, more probable that injury occurs during the cutting. The entire thickness of the silicified membrane adjoining the midrib is about 8-10 times as large as that of the fine envelope. As soon as the knife presses against this solid mass, the cap easily breaks off, which appearance is also observed with thicker masses at the central nodule crumbling out. In order to clear up this point I have made another series of sections according to method 1, in which injuries are more avoided. The best thereof show unmistakably at the base of the furrow this fine capping envelope exactly as represented in figs. 1–3. If the transverse section goes through the central nodule, the image then becomes as in fig. 4. Hence the nodule is also here a strong thickening of the midrib inwards; outwards it has no distinction beyond that the middle line is broken and does not appear in the transverse section of the cleft. The membrane is flat. Here it should be noted that Schumann (23, p. 74) observed two focal images of this nodule in *Pinnularia lata*. I have seen them oftener in *Pinnularia major*. But they do not arise through a channel, as supposed by Schumann, but are produced by a depression in the centre of the nodule. This may often be seen without difficulty in a side view of the entire frustule. Similarly, the end nodules are inward projections.

I will now proceed to the description of the longitudinal sections. Their appearance must of necessity differ, depending upon whether the section goes through the openings of the chambers, or near the midrib, or near the edge of the frustule. Fig. 5 represents a section through the chamber-openings showing the siliceous membrane with numerous long pegs projecting inwards in the frustule; these are the vertical partition-walls of the chambers.

In fig. 6 we have a median longitudinal section; the chamber-spaces appear like beautiful squares slightly rounded off in the wall-substance. The longitudinal section taken from the chamber-opening towards the edge shows hardly any difference from that last described. A vertical section along the midrib and through the central nodule has hardly any importance. If a longitudinal section goes a little obliquely towards the midrib, it shows in places the image in fig. 5, and in other places that of fig. 6. In all cases the outer limit of the cell-wall is perfectly straight throughout; nothing in the outline suggests furrows on the surface. From this representation it may well be supposed that transverse as well as longitudinal sections of *Pinnularia* are vexatious prepa-

rations in the hands of the tyro. In one and the same section he observes the most beautiful closed chambers and is fully convinced that my description of the *Pleurosigma* chambers is accurate. A few micro-millimetres further on he notices the magnificent projections of the wall, not inferior to those of the epidermis or the vessels of higher plants, and with this he proves that I have erred in all points. If he follows Pfitzer's advice with regard to breathing on the sections and thence obtains a mass of fragments, he will know neither what is outside nor what is inside the valve. For instance, if he turns round fig. 5 he will then see, according to his taste and intelligence, Pfitzer's furrows on the outer surface, and then he confirms all Pfitzer's fairy-tale. Therefore I admonish every one to use the utmost precaution in interpreting the images!

§ 2. *Collodion Casts.*—For the technical process I refer to my former essay (6, pp. 489–90). These casts are of much greater importance with *Pinnularia* than with *Pleurosigma*; I can therefore seriously recommend sceptics to try my experiments. The method is so easy in practice that even inexperienced manipulators, unable to do the cutting, will in this way obtain a general view of the details. It has been already observed that the chambers can be injected from the opening, so that in pouring fluid collodion on the inner side of the valves, it enters the opening and fills the chambers. With the evaporation of the ether the mass contracts, and after the collodion has hardened one sees the contents of the long cylindrical chamber shrivelled-up to a thread. The image takes the shape of the letter T. The vertical line is the collodion filling up the chamber-opening; the horizontal is the collodion which fills the space of the chamber. If, therefore, the *Pinnularia* valve is taken away from the cast, these small T's stand in military order in lines parallel to the midrib on the film. This T is mostly so elastic that without breaking it can be pulled out of the chamber.

Fig. 7 is intended to bring clearly before the mind in a diagrammatic form what I have described above for a small portion of the cast; it is impossible to draw it exactly, because the interpretation chiefly depends on the alteration of the focus. With the lowering of the tube the horizontal T threads appear before the surface of the envelope is seen, and they disappear when the latter becomes visible. It is, of course, desirable always to examine for oneself such a cast. The central nodule leaves behind a pretty bold depression of elliptic shape. Sometimes are seen two small flat cavities adjoining each other, which also indicate the depression in the centre of the nodule (as above stated). Except the broken line in the middle, the collodion cast of the outer surface of a valve shows only a perfectly plane surface; but this line increases in distinctness near the central nodule and ends with a thickened point. This fact

implies that the cleft furrow is very deep, a fact which is also confirmed by the transverse sections. This is simply the consequence of the gradual increase in thickness of the entire membrane, whilst the closing envelope is probably of even thickness. Closer observation will show that the surface is not everywhere alike; the area along the midrib, i. e. the portion free from chambers, appears quite plane; the other, on the contrary, a little granulated, and occasionally one can even see a kind of glitter of chambers. In this case the cast teaches more than the longitudinal section, since it seems to display an unusually fine surface-difference which is not brought to the eye by the longitudinal section. Similar experiments were made with *Pleurosigma*. As a matter of course, this condition of surface has nothing to do with transverse striæ of *Pinnularia*. I am still in doubt whether this image is not called forth by the different evaporation processes above the chambers, therefore perhaps it may not correspond to any real difference between the valve surfaces. It is true that where air-bubbles are in the collodion the surface after hardening looks different from what it does when free of bubbles.

Thus a complete and exhaustive explanation is given of all appearances of the surface image of a *Pinnularia*. In the imbedding of the valves in balsam, chamber and opening are filled with the strongly refractive substance and thus produce the coarse transverse striæ. Each stria is a chamber.

§ 3. *Staining Processes.*—I cannot call these experiments more than tentative; they were intended, after I had recognized this most interesting condition of the chambers, to provide preparations in which the chamber-spaces alone should be filled with colour. The wall-substance, as is well known, does not take the staining. The experiments were made with solution of silver, picro-carmine, and Prussian blue; with the latter substance only I obtained preparations which were partially serviceable. The valves were put in aqueous solution of Prussian blue, poured off after some time, immersed in alcohol and constantly shaken to remove the blue which had deposited in and upon the valves. They were then put into balsam. In successful instances, not occurring frequently, the chamber is seen blue in the colourless wall. I have not persevered with these experiments.

§ 4. Passing on now to the literature on *Pinnularia* sculpture, Schumann as far back as 1867 was approximately correct in his views. In his work (23, p. 73) he says that "in a fragment in partially reversed position the channels were most raised at the middle; each channel seems to consist of two vertical walls, the vault across being open towards the middle line." On pl. IV., fig. 54, B, he exhibits such a fragment, from which one can imagine what he means. The real state of affairs could not be discovered

by Schumann's method; it is therefore unnecessary to enter into the details of his statements. A considerable retrocession is found in Pfitzer's works of 1869 and 1871 (18 and 19). In the former is briefly indicated that in *Pinnularia* we had to deal with smooth, narrow, elliptical spaces, concave outwards (pores = costæ, Smith). In his second he substantiates this view by details. His views do not require special refutation; they are wholly wrong.

In my lecture (7) I first gave a correct representation of the real details, with preparations. It seems a pity that this lecture, referred to by Pfitzer (1873) in Just's 'Jahresbericht' (11, p. 28), did not give him occasion to make once more transverse sections of *Pinnularia*, for in all probability he would have been luckier. The most recent paper, however, which has come to my knowledge is a notice by Prof. Hallier, April 1882 (10, p. 136), according to which he holds a similar view with regard to the structure of the silicified membrane of *Cymbella* as Pfitzer expounded for *Pinnularia*. If this can be looked upon as a confirmation for *Pinnularia*, then I do not envy Prof. Pfitzer's new triumph, which places Hallier's reputation in an unfavourable light.

Among the supporters of this unfortunate furrow-hypothesis seems to be Borscow, whose work I have not seen (*vide* Pfitzer, Just's 'Jahresb.,' 1873, p. 28).

The literature as to the supposed perforation of the cell-wall along the middle line has been given above. I need only add that Pfitzer (19, pp. 175–80) has tried to dispose of Dippel's objections to Schultze, and seems to have succeeded tolerably well in his so-called proof of the longitudinal cleft. But when he states that, in explaining the apparent movements, Dippel has put by far too great weight on the endosmotic processes, this objection falls to the ground, since Prof. Engelmann (4) has discovered a means in Bacteria to demonstrate the development of oxygen by diatoms under the Microscope, thereby furnishing the proof that the unseen gas-molecules escaping from the cell cause movement. Be this attraction or not of the Bacteria, these currents of gas, like entering or flowing currents of water, must have such force that they can carry away a detached cell.

2. *Navicula.*

Of the numerous species, I have only examined the coarser striped *Navicula lyra*, Ehrb. The material was obtained from the mud gathered during the expedition of the "Pomerania" (9). I chose a serial slide, on which were placed twenty-seven transverse sections through one valve. The lengths of the first and last sections led me to suppose that three or four sections had already been made from the valve at either end, and by mischance are not on

the slide; consequently the sections are not all perfect, for a medium-size valve often contains more than sixty rows of dots. Be this as it may, several sections are excellent. From this I infer that the "lyra" figure is produced by thickened and chamberless portions of the cell-wall. In like manner, the central nodule is a large flat thickening of the wall. Fig. 9 probably shows the section exactly through the middle of the valve (No. 13 of the series); fig. 10 section not far from the middle (No. 17 of the series); fig. 11 section not far from the end (No. 1 of the series). In the two last we see the thickenings, which I have designated as "lyra plates," clearly project inwards. The sculpture of the dotted portion of the valve may really be regarded as similar to *Pleurosigma*; but here are clear rows of isolated chambers closed all round. Towards the edge the valves become thinner and the chambers smaller. The midrib with the chambers adjacent to it can only be seen faintly on most sections, especially the projection inwards is seldom distinct, and in the first section, fig. 11, is not seen. Longitudinal sections were not made; they probably would illustrate the details more beautifully. Combining with these results the surface view of a valve, fig. 12, we arrive at the conclusion that the doubts I formerly entertained (6, pp. 482–4) with regard to the existence of closed chambers, and of double membranes connected by column-like supports, are unfounded. The clearly separated spherules of the surface image also show separated chambers, and this is equally true of the entire series of rows. The space between such rows of dots, which is not rarely twice the breadth of the chamber diameter, represents without doubt the solid wall, which has not suffered a visible separation; hence there is no communication between the separate rows. If we have thus before us the connecting link to *Pleurosigma*, it only requires another step to arrive at *Pinnularia*: if the chambers forming one row are brought together a little closer and coalesce with each other, then we get the extended cylindrical chamber of the former. It is true that the large opening is unconnected.

3. *Pleurosigma.*

§ 1. *Addenda to my former researches.*—I add a few recently obtained results, chiefly due to the method subsequently learnt of placing the frustules in position and making serial sections (*vide supra*, "Method of Investigation," (1).

(1) I was formerly obliged to neglect the transverse section of the central nodule (6, p. 478), because I could not find it; but in serial preparations of *P. balticum* as well as *P. angulatum*, cut exactly transversely through a bundle, there is no difficulty in

detecting it. In order to remain quite objective on this point with regard to the sculpture of *Pleurosigma* in general, I have made photographs of a number of transverse sections, and amongst these one of a central nodule of *P. balticum* (French specimen, 6, p. 480). This shows without doubt that, as already proved by the cast process, the nodule is a solid thickening of the wall projecting inwards.

(2) The *Girdle-band* was formerly described by me (6, p. 480, figs. 11 and 13) as a simple membrane. Pfitzer refuted this correctly (19, p. 20). In my present sections made exactly transverse to the median line, I see it sometimes single and sometimes double, probably due to the close proximity of the two plates. If I gave no figures of this formerly, the reason was that in cases where it appeared double I concluded that accidentally with the imbedding in gum foreign matter adhered there, a supposition which might be excused by the fact of using only sections made through frustules lying pell-mell.

(3) What I termed with *P. balticum* accessory rib (6, p. 481, and fig. 13), namely, a small second rib-like edge on the one side of the real median line, does not change position in all cases. For example, if it lies on the right of the main rib in one valve it will, as a rule, be seen in the other valve on the opposite side, that is, on the left. Exceptionally it may be found in both valves on the same side. Numerous experiments by crushing *Pleurosigma* valves under heavy pressure have taught me that, contrary to the former (6, p. 484) negative result, we can sometimes find fragments in which the one membrane is isolated, that is to say, it appears without any markings because the chamber-walls are rubbed off. This, however, is only found in a very narrow edge-portion of such fragments. Which membrane it is—whether the inner or the outer—cannot be determined as a matter of course. Mistakes with such fragments of uninjured valves, in which the markings are indistinct because the chambers are filled up with a glutinous substance, are avoided by convincing oneself of the much higher refraction of the valve in this case, whilst the isolated membrane is seen only very faintly.

§ 2. *Investigations by others.*—(1) Pfitzer in his essay (19, p. 174) speaks of the sculpture of the cell-wall of *Pleurosigma*; but since nothing new is mentioned, I refer on this subject to the General Remarks given in the third part of the present paper.

(2) Müller has also studied the question. I had sent him a slide of *Pleurosigma* sections from the same gathering as the French specimen described in my original paper, and soon after I received from him two essays (14 and 15). As he was a novice in section-making who had occupied himself with coarse objects only, I treated his strange attacks with silence, in the hope

that an able observer would take up the matter and confirm my work, whereby I should have been relieved of the trouble of replying. In this hope I have for ten years been disappointed, and I am obliged now to refute Müller.

I do not know whether Müller has made *Pleurosigma* sections according to my method, or whether his statements are made from examination of my own preparations. He says that my drawings are incorrect, especially that the diameter of the transverse section of the walls is proportionately much too thick, whilst the strong refractive thickenings at the ends of the same are not sufficiently given, hence he will not admit the existence of closed chambers (15, p. 621).

With regard to this question, I have to reply that all my preparations of *Pleurosigma* were not only submitted to the late Max Schultze, and every doubtful and difficult point demonstrated before him by me personally, but that my diagrams were recognized by him as correct, and by his express desire my paper was communicated to his 'Archiv.' This I mention without putting high value on the influence of mere authority. Next I refer to my own paper: on pp. 82–84 I discuss in considerable detail, with reference to the coarsely marked *P. balticum*, the point as to the existence of columns between two envelopes or closed chambers. Nobody will infer from my description and diagram that I meant cylindrical columns or chamber-walls of equal thickness, nor that I intended to deny the thickenings at the ends. No such idea was in my mind. But if such end-thickenings do exist it is an understood thing that they are of pyramidal shape, the base towards the membrane, the point towards the space between the membranes, and they must operate as strong refracting bodies just like small convex lenses. On p. 511 I illustrate for this purpose the most striking comparison—the liver-wort leaf with large mesh-work. Choosing for study sections of a considerable thickness, and in which therefore two entire chambers might be found lying one over the other, then the effect is doubled; the two membranes will be seen more conspicuously projected from the inner space with the thinner walls. But such sections I did not select for my diagrams, it being the rule, whenever the finest structural details were under investigation, to examine and to draw the thinnest sections or the extreme margin as the most reliable portion. In examining such sections one sees the detail exactly as I have represented it, and I must continue to assert that my diagram is true to nature.

A second point of attack to be disposed of is Müller's idea that his flooding experiments (14, p. 75, and 15, p. 621) could not be brought into harmony with chambers closed from outside. I put entirely aside the value of such flooding for the elucidation of details of diatom structure. That all the fluids named by him

will penetrate the interstitial molecules of thin membranes with the greatest facility is known to every novice. Were one to suppose or to search for holes with this experiment we should cancel every investigation made during a century with regard to endosmose. This point needs no refutation. I refer to what I said, pp. 487–8, about the penetration of water into the valves, and it will be the same with all other fluids. The further deductions by Müller, pp. 622–5, in connection with his flooding experiments are by far too obscure for me. Even admitting the facts with regard to *Pleurosigma* were as Müller believes, that the chamber had an opening outwards as with *Triceratium*, there is no reason whatever to infer that the microscopical surface-image could be altered in air, balsam, bisulphide of carbon, &c. The chambers whether elliptical or spherical in connection with the wall-nodule operate in the one case as concave lenses, in the other as convex lenses; whether they have an entrance from outside or not is immaterial. If entrances do exist, but which up to the present have not been observed, I would sooner admit that they lie on the inner side of the membrane. In support of this statement is the analogy of *Pinnularia* and the collodion cast showing a delicate relief-image of the inner side (6, p. 493).

(3) Müller seems to think (14, p. 76) that we ought to investigate the real condition of diatom structure indirectly, and especially the *Pleurosigma* sculpture, and in illustration he describes his investigation of *Triceratium favus*. On pp. 79–80 he has no hesitation in applying to *Pleurosigma* what he found with *Triceratium*. This means, in other words, that everything said by Flögel with regard to *Pleurosigma* does not quite agree with what I (Müller) found out with *Triceratium*, therefore the former must be wrong!

(4) The fourth point is Müller's representation of a transverse section of *Pleurosigma* (15, fig. 1 *a* and 1 *b*). He writes (p. 637) that he succeeded in finding it amongst numerous sections, and then he terms it (p. 621, and explanation of fig. on p. 641) *P. scalprum*, with a sign of interrogation. What he has represented there is a fragment of a very thick transverse section of *P. balticum!* I cannot avoid calling this a prodigious blunder. For Müller, after his researches with diatoms, ought to know that the small delicate *P. scalprum* could never furnish such a colossal transverse section, in whatever direction made. Further, on p. 488, fig. 19, I have described and figured the transverse section of *P. scalprum*, and the fig. is on the same scale as the transverse section of *P. balticum*, fig. 13. A confusion between these two is utterly impossible.

4. *Surirella.*

In a very primitive form Rabenhorst, 1864 (22, p. 9, fig. 12 *d*), gave a transverse section of *Surirella*. It is rectangular, with short straight lines at the corners. The sculpture of the valve was minutely described by Pfitzer (19, pp. 108–10, pl. I., figs. 8–10, pl. V.), and the former researches by Smith and Focke were considered. About the finer sculpture which produces the transverse and longitudinal striæ Pfitzer said nothing. The representation of the coarser details may serve as a model, and I shall refer to it frequently. The only species closely examined by me occurs in fresh water, and I believe it to be *S. biseriata*, Ehrenb. The minute drawing on the surface is like the well-known test-object *S. gemma*. From a single valve of this species I made a series of transverse sections, from another a series of longitudinal sections, and lastly a collodion cast of the inner side of a valve.

The general outline of the valve, best seen from the cast, is an elongated oval almost like a lancet. In the middle lengthways is a ridge, on the margins are the wings as described by Pfitzer in *S. calcarata* (19, pl. I., figs. 8–9, pl. V., fig. 6). The surface between the middle line occupying the highest edge of the ridge and the wings is bent somewhat wave-like. The wings are not simple membranes, but are double, a fact already established by Focke and Pfitzer. They are really folds in the cell-wall. Both membranes adjoin closely in some places; in certain intervening spaces corresponding to the waves on the surface they are not close together, but show a tube-like space. All these communications end in a delicate continuous tube, which forms the tip of the wing.

The diagram of *Surirella* consists of (1) a midrib without nodule or any other distinction; (2) numerous transverse ribs which extend at pretty regular distances from the midrib towards the edges; (3) transverse lines between these ribs and perfectly parallel to them; (4) longitudinal lines of extreme delicacy which cut the transverse lines at right angles. We will now examine the result of the transverse sections. The transverse section series commences with a section the shape of which suggests that three or four had been taken before; the last, No. 66, has had at least ten successors of equal thickness. From these facts we may appreciate the delicacy and extreme usefulness of this series. Fifty times over these sections substantiate the correctness of Pfitzer's images. I have drawn Nos. 2, 9, 39, 40, and 66. Of the longitudinal section series I draw only the first, pl. IX., fig. 18, and another, fig. 19, which goes through the middle of one valve, and is the most instructive, as it shows most distinctly the waves on the surface. My longitudinal section series has not that technical

perfection which distinguishes my transverse sections, although it shows nearly all one can reasonably expect. Putting transverse and longitudinal sections together, one readily sees that the former must look a little different when they are cut through the elevations or when through depressions. Pfitzer has already drawn attention to this fact, and as far as I can judge he has deduced it from the optical transverse sections of the raised frustules (p. 109). The real transverse sections confirm his view. It is not uncommon that the section is so thick, that lying at the declining edge of a wave its outlines in the upper part differ from those in the lower. Figs. 13, 15, and 16 illustrate this by finely drawn lines. These are differences which occur with the transverse section of the wings. The section goes either through a place where the membranes holding together the wing lie closely one upon another, exhibiting the image fig. 14; or else it goes through the intervening space, then the wing looks like a flat-pressed smooth surface having a lumen in open communication with the cell (fig. 15). In the former case one observes at the highest margin of the wing the transverse section of the extremely thin tube above mentioned. Pfitzer (*vide* p. 110) has expressed the opinion that along the entire wing-margin runs a fine cleft, or that there exist a large number of extremely small openings standing in one line. This cannot be taken for more than a mere opinion. My transverse sections in no way corroborate this opinion; on the contrary, they show these fine marginal tubes closed everywhere outwards. These details can be best understood by comparing it with the surface view of the wing, fig. 18. By comparing the figured transverse sections together it will be seen that the proportion of the size of the wing to the surface towards the end is different from what it is in the middle of the valve. We see further that there is a difference in the curvature of the surface of the valve, about which more further on. With regard to the finer sculpture, the transverse sections exhibit the midrib as an irregular thickening; one sees there a point. However, the membrane in its whole extent is so extremely delicate (the measures give $0{\cdot}4$–$0{\cdot}5\ \mu$, even this is too high) that it becomes very difficult to distinguish differences of thickness. Transverse ribs are delineated in the longitudinal section (figs. 19 and 20) clearly like small ovals on the crests of the waves, and these ovals are mostly more pointed whilst the valleys are rounded. I see the transverse striæ in the delicate longitudinal sections as clear pearl-like punctures, as in fig. 20. No rib-like projection can be observed, however, for the shadow permeates the whole mass so that it must necessarily be caused in a manner similar to *Pleurosigma*. The longitudinal striæ I could not perceive with the desired clearness in the thinnest transverse sections, not even with oblique light. Sometimes I observed a kind of glimmer, but nothing

beyond this. With central light the transverse sections appear homogeneous, and flat on both sides. In examining the sections I could not trace differences in the membrane thickness; nor did I observe projections or continuations with one exception near the edge of the valve outside the wing, and this occurs pretty constantly and may stand in connection with the attachment of the girdle-band. On this matter I cannot give more definite explanations. If we examine the cast in view of these facts, the wave shape of the surface is thereby substantiated; it follows that the fluid collodion must have entered into the tube-system of the wings, and in pulling off the valve there must have been left behind contracted tubes. In reality, not far from the edge, such protuberances of collodion are seen at regular intervals. The cast shows absolutely nothing of the transverse striæ however oblique may be the illumination with which it is examined. From the above we infer, with regard to the finer sculpture, that midrib and transverse rib are both wall-thickenings of which the transverse striæ have probably been produced by the cylindrical hollow spaces within the membrane. Small hollows of these cylinders then suggest an appearance of longitudinal lines, and the condition is similar to the transition of the simply striped *Pinnularia* to the pointed striped *Navicula*. This lesser definition remains obscure. For microscopists these investigations about *Surirella* sculpture are of some importance, since they explain various peculiarities of *S. gemma* which may be looked upon as similar to *S. biseriata*. At first sight the longitudinal section, fig. 19, teaches us that it really is no brilliant performance for an objective when it shows the much-spoken-of longitudinal striæ everywhere at the same time. All that is proved is that the objective possesses the power of showing at the same not only striæ which are within the focus but others which are beyond. This can be easily obtained with bright sunlight, but with ordinary daylight an objective should only show clearly either the striæ on the elevations or those on the depressions. Secondly, the transverse section near the end, fig. 14, establishes the fact that in order to see both striæ at the same time it is best to examine the end portions of a valve under an obliquity of illumination of 45° to both directions. Here the surface of the valve is smoother. Altogether *Surirella*, on account of its uneven surface, is a very unsatisfactory test-object.

(*To be continued.*)

XII.—*On a New Microtome.*

By C. Hilton Golding-Bird.

(*Read* 14*th May*, 1884.)

The necessity for providing some instrument which offered the advantages of modern microtomes and yet was within the reach of those whose work being of intermittent character did not warrant their employing the somewhat elaborate instruments that are found in laboratories, made me originate the instrument shown in figs. 83 and 84.

The microtome is intended to be held in the hand during use, and is of two forms—one for ice and salt, the other for ether. The former (fig. 83) consists of a cylindrical vulcanite chamber closed at the bottom by a brass screw-lid, and at the top by a

Fig. 83.

Fig. 84.

disk of vulcanite, having in the centre a plate of brass (freezing plate) 7/8 in. in diameter, and terminating in the chamber by a rod of brass. A metal cap surmounted by a glass plate and pierced in the centre to allow the freezing plate to project, screws over the upper end of the cylinder, the outer surface of which bears a male screw of hard metal on which the cap turns. As the cap is turned round a spring catch clicks at given intervals; these are so arranged that as the cap rotates from left to right each click shows that it has sunk on to the cylinder 1/1000 in.; hence any tissue fixed on the freezing plate projects, at each click, 1/1000 in. through the hole in the glass plate of the cap, and a

razor now passed over the latter cuts off a section of the same thickness. By turning the cap through half an interval, sections of half that thickness may be obtained. To fix the specimen it is only necessary to fill the cylinder with ice and salt, the specimen being previously prepared in gum, according to the general rule when freezing is employed as the means of imbedding.

The form in which ether is the freezing agent employed (fig. 84) differs mainly in the fact, that the lower half of the cylinder is a chamber for holding the ether, with the two nozzles that give the necessary jet. The freezing plate, cap, and regulating apparatus are the same as in the ice and salt machine. Mr. Swift (to whose skill and ingenuity the details of manufacture are due) has introduced a very ingenious but yet simple means whereby some of the ether can be saved from the spray; much must of course escape, but much also falls back on to the jets again (since the spray is a vertical one); this portion impinges on to a funnel-shaped diaphragm, which acts as a lid to the ether chamber, and through which, by means of a minute opening, it again finds its way back to the ether chamber.

For those who, like myself, have to work for a large histological class, there is nothing equal to the Groves-Williams ether microtome in the laboratory: but for intermittent and home work I believe that the form of instrument that I present to-night, leaves scarcely anything to be desired in accuracy of work, simplicity, convenience, and portability.

XIII.—*On some Appearances in the Blood of Vertebrated Animals with reference to the occurrence of Bacteria therein.*

By G. F. Dowdeswell, M.A., F.R.M.S., &c.

(*Read* 11*th June*, 1884.)

The occurrence normally, of micro-organisms in the blood and tissues of healthy animals, has been the subject of many observations, in some instances with contradictory results. It is, however, now well established that, both in man and other animals, they are constantly present in certain situations, not only in the mouth and lower intestine, but in some cases at least, in the liver and pancreas; on the other hand it has been shown that in the blood they are not usually present in a state of health. To determine this latter point microscopical examination is inadequate, inasmuch as mere negative observations are inconclusive, and the question has been decided by physiological experiment, viz. by taking blood from the heart or vessels, with precautions against contamination, when it is found that it may be preserved indefinitely, free from septic changes; and even in some instances, as has been demonstrated in King's College by Professor Lister, without coagulation.

In some pathological conditions—in certain infective diseases,—as is now well known, micro-organisms are found constantly present in the blood, and in a few cases are shown to constitute the true contagium, the actual *materies morbi*. It is possible too, that in other conditions not yet investigated—as for instance in a temporary access of fever—they may appear here, starting from those situations in which they are normally present, and again shortly disappear. For the determination of the question of their occurrence in these situations, it is essential that such other bodies as may be, and have been, in some instances mistaken for them, should be well known.

The appearances in the blood which I have to record to-night have been already described by myself or others, and I have but little that is new on the subject now to offer. Mistakes, however, that have been made—in one case in a report published quite recently—show that these phenomena are by no means generally known or recognized.

1. *Max Schultze's Corpuscles.*—The first instance to be here mentioned is, that in the blood of man and many animals, besides the red and white corpuscles there are present normally, though in very variable numbers, small corpuscular bodies, the nature of which has been the subject of great diversity of opinion, and is far from being as yet determined. These are known as Max

Schultze's corpuscles, so-called from their first observer. The most careful investigation of these is that by a Fellow of this Society, Dr. Osler,* who has given a full description of them, with drawings. He observed them both within the blood-vessels and in preparations on the slide under the Microscope, but he leaves their nature and function quite undetermined, though his observations are valuable, inasmuch as he showed that whereas in preparations under the Microscope they are found in masses, within the blood-vessels they occur singly, isolated forms being distributed throughout the blood-plasma. Though their appearance should be familiar to every student of histology, they have undoubtedly often been mistaken for Bacteria, as obviously is the case in the recent report of one of the most important investigations of the day, to which I have just referred—a circumstance which fully justifies their careful examination and description in this relation. In size they are very variable, from half the diameter of a red corpuscle to very much less. In shape many are spherical or discoid, some pyriform, or more exactly, shaped like a comma, or spermatozoon-like, as Osler terms them; others quite irregular. Some appear distinctly coloured as the red corpuscles, though paler, from their smaller size or thickness.

I have made frequent and prolonged examination of these bodies, and can state from my own observations, that they are not independent organisms or microphytes, as has been supposed, and I believe that a large portion of them at least, are mere débris, disintegrated red corpuscles; they may be indefinitely increased in numbers, with identically similar forms, by treating a preparation of blood on the slide with a 10 per cent. solution of sulphuric acid; though somewhat strangely, this has been stated to be a good preservative fluid for the red corpuscles.

It has been shown by Riess that they have a pathological significance, in so far that they vary in number in different states of health; it also seems to me that they increase and diminish at certain periods of the day, as do the white corpuscles; both these conditions agree with the view that they are disintegration products; and if this be so, their numbers would probably be enormously increased in cholera and similar wasting diseases, in the abnormally active metabolism of the tissues. On the other hand, however, they appear to have been regarded by some as representing an early stage of the development of the red corpuscles, the so-termed hæmatoblasts, but the description of these is so vague that it is difficult to arrive at any conclusion respecting them.

It appears to me, however, that in many cases in the descriptions of these corpuscles hitherto published, bodies of two different characters have been classed together, the one of regular discoidal

* Proc. Roy. Soc., xxii. (1874) pp. 391–8, and Mon. Micr. Journ., 1874.

or spherical form, very variable in size, from the most minute up to nearly half that of a red blood-corpuscle; these appear to be the blood-plates of Bizzozero, and very possibly have an evolutional significance: those of the other class, which more particularly relate to the present subject, are always comparatively small, and more or less irregular in form as above described.

Though the bodies here in question—Max Schultze's corpuscles—are not mentioned in many treatises on microscopic anatomy, yet as they appear to be always present in varying numbers in the blood, whether they are evolutional or involutional forms, they must be regarded as part of its normal constituents; and with respect to the subject here under consideration, viz. investigation of the micro-organisms which occur in these situations, must not be overlooked. The occurrence of the mistake I have mentioned, which shows that they are not always well known, where pre-eminently they ought to be so, has induced me to refer to these bodies at some length.

2. *Proteid or Addison's processes of the red corpuscles.*—The next appearances which I have to mention, resemble Bacteria far more closely than the former, indeed morphologically they are indistinguishable from them; they have been described by several writers independently, in many cases apparently without knowing what had been observed by others. In general, in a preparation of blood under the Microscope, they appear first as small protuberances or bud-like processes on the surface of the red corpuscles, very similar to the first stage of gemmation in a yeast-cell; these sometimes develope—as when the preparation is treated with a 5 per cent. solution of ammonium chromate—to broad pseudopodial processes, in some cases of comparatively considerable dimensions; at other times they form long fine filaments, apparently continuous, unsegmented, three or four times in length the diameter of the corpuscle, of variable thickness, but frequently so fine as to be with difficulty recognizable with the highest powers of the Microscope; at other times they form rosaries of minute spherules, similar to the torula form of micrococci, or the spores of *Penicillium*. In general they very shortly become detached from the parent corpuscle, and may then be observed free in molecular movement in the field of view, simulating exactly Micrococci, Bacteria, or Bacilli; at other times they are retracted within the plasma of the parent corpuscle. I have previously regarded this occurrence as due to the spontaneous contractility of the substance of the red-corpuscles, thereby shown to be protoplasmic; but I must here qualify that opinion, inasmuch as it has lately been demonstrated in a very ingenious experiment, by Haycraft, of Edinburgh,* that egg albumen, inclosed in an indiarubber ball perforated with minute apertures, and placed in a

* Proc. Roy. Soc. Edin., 1880–1, p. 29.

neutral solution of suitable specific gravity, upon the ball being pressed will throw out filamentous processes, which are retracted on the ball again expanding, showing that such processes are not necessarily protoplasmic; they, however, demonstrate another point in the constitution of the red corpuscles, viz. that they have no true cell-wall or membrane, as has been sometimes supposed.

These appearances were first described and figured in the Quart. Journ. Micr. Sci. for 1861, by the late Dr. William Addison, F.R.S., and after him may be appropriately termed Addison's processes. He induced them by treating blood on the warm stage with a solution of sherry and salt solution or quinine; they may also be produced by many other reagents and conditions, as I have previously described in the same journal, 1881, where I have collated the previous observations upon them. They are readily produced by solutions of septic matter, and I have frequently observed their occurrence spontaneously—that is without the addition of reagents—in the blood of septichæmia examined under the Microscope, where they have also been observed by others, but without apparently recognizing their nature. In the report of the French Cholera Commission in Egypt just published,* filamentous processes from the red corpuscles of the blood kept in the incubator for some days † are recorded, but without further observations upon them. They probably occur also in many other pathological conditions. They are produced by heat, as described and figured by Dr. Beale and by Max Schultze, through a mere disintegrating action; also by treatment with gas, as recorded and figured by Professor E. Ray Lankester. In the blood of the frog they occur conspicuously, and are more readily produced there than in the higher animals. The appearances herein have been described in sensational terms by some German writers, but so vaguely that it is impossible to be certain what is intended, whether these processes of the red corpuscles or true micro-parasites, one form of which has been fully described by Professor Lankester; others are said to occur frequently at certain seasons, but I have not been able to confirm this latter observation.

These processes when detached from the parent corpuscle, are not, as I have said, to be distinguished morphologically from Bacteria, and their behaviour to micro-chemical reagents is difficult to observe, from the impossibility of keeping these minute bodies within the field of view. Upon and during such treatment they are not appreciably swelled or decolorized by water, as are the red or white corpuscles; nor is the action of acids or of alkalis much more apparent; they may, however, be distinguished from

* 'Archives de Physiologie Normale et Pathologique,' 1884, p. 411.

† And others after a longer interval, at the temperature of the air (Lostorfer's corpuscles ?).

Bacteria by their behaviour with the anilin dyes, by which, as by methyl-anilin-violet, they are only stained faintly, like the red corpuscles, while all forms of Bacteria, with a very few exceptions, are readily and deeply coloured by this salt. Since the publication of my own account of these bodies, their formation by the action of some reagents has been observed and described by Dr. Stirling,* and most recently in the blood in cholera as mentioned above.

Conclusion.—Thus it is seen that there are several appearances in the blood which may readily be mistaken for micro-parasites—to use a comprehensive term—though the occurrence of the latter is probably more frequent in abnormal and pathological conditions than yet recorded. The increasing importance of this subject renders it desirable that every observer should be familiar with these appearances. I pass over here coagula, granules, and pigment, which frequently occur in blood, the external form of which, if carefully observed, sufficiently distinguishes them from the cells of living organisms.

But while, on the one hand, other bodies are mistaken for Bacteria, in some cases veritable forms of the latter have been asserted to be but fibrinous coagula, or in another case mere organic crystals.

Apart from the subject of pathological appearances and the occurrence of foreign or parasitical bodies in it, the normal form elements of the blood, after the observations of nearly two centuries, are far from being exhaustively known; the varieties of the white corpuscles, of which there are several, have been little more than suggested; some phases in the evolution of the red corpuscles, as is asserted, have been but very recently observed; whilst the functions, origin, and destination of Max Schultze's corpuscles are scarcely more than conjecture: and whilst, on the one hand, the micro-parasites of the blood, its abnormal or pathological features, furnish a subject for examination with, and an excellent test for, the highest powers of the Microscope, its normal characters offer a field of investigation for moderate powers, with a prospect of most valuable results, one that is always readily available, but which has hitherto been somewhat neglected by microscopists generally.

* Journ. Anat. and Physiol., 1883.

XIV.—*On Protospongia pedicellata, a new compound Infusorian.*

By Frederick Oxley, F.R.M.S.

(*Read 11th June*, 1884.)

This interesting organism was first discovered by me in a pond near Snaresbrook, Essex, in the spring of the year 1882. I was searching the numerous ponds in that neighbourhood for *Volvox globator*, and happened to dip a bottle amongst some rushes in a quiet corner, which appeared to be a likely place to find what I was looking for. On holding the bottle up to the light I observed in it a number of minute flocculent bodies, the nature of which I could not determine with a pocket-lens, and therefore carried them home for further examination.

With the Microscope I found them to consist of colonies of monads possessing collars and flagella, and connected together in vast numbers and in rather close proximity to one another on the periphery of some exceedingly transparent hyaline substance.

Being out of health, and, moreover, having only a very slight acquaintance with the group of Choano-flagellata, derived from Mr. Saville Kent's papers in the 'Popular Science Review' and 'Monthly Microscopical Journal,' and from some specimens shown me by my friend Mr. Charles Thomas, of Buckhurst Hill, I did not at that time recognize that any new discovery had been made, but I gave some specimens to Mr. Thomas which we examined together, and also spoke of them to another microscopical friend, Mr. C. Livingston, who resides near the pond out of which they had been obtained.

In the spring of the present year, 1884, I again visited the pond in company with Mr. Livingston and Mr. Thomas, and there found the organism again in great abundance. Mr. Livingston took great interest in the little creatures and examined them under very high powers, and made measurements and computations from which it appeared that the bodies of the individual monads are from the 1/3000 to the 1/2500 of an in. in length, the collars when extended being about twice, and the flagella five to seven times the length of the bodies, and that the number of individuals composing a colony amounted to from 10,000 to 20,000 or more. Mr. Livingston was not able from Kent's 'Manual of the Infusoria' to identify the species, the nearest approach to it appearing to be that described by Mr. Kent under the name of *Protospongia Häckeli*. He therefore sent Mr. Kent some specimens for identification. Mr. Kent considered the specimens undoubtedly new, and interesting to him as tending to support the conclusion he had arrived

at as to the relationship between the Infusoria and the sponges, but being on the eve of his departure for Tasmania he was unable to pursue the subject. Mr. Kent also pointed out the fact, which my friends' and my own observations have since confirmed, that each individual monad is furnished with a short pedicel or footstalk by which it is held in position in the zoocytium, this footstalk, according to Mr. Livingston's measurement, being about the 1/10,000 of an in. in length.

Specimens, accompanied by a short description, were sent to Herr von Stein, who gathered from the description that the species was new; but the specimens themselves were lost in the post. A specimen mounted with osmic acid has, however, since been sent, which has enabled him to confirm his opinion.

The drought we have experienced for some weeks past has so dried up the pond from which my specimens were obtained, that no more are to be had at present, and I have not therefore been able to satisfy myself that *Protospongia pedicellata* agrees in all points with Mr. Kent's description of the genus; but so far as my obser-

Fig. 85.

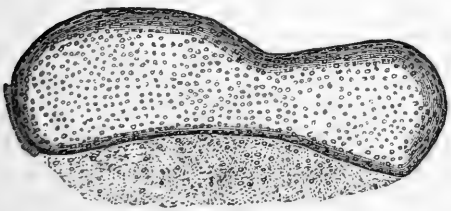


Fig. 86.

vations have extended, it differs from *P. Häckeli* in the possession of a footstalk and in the number of individuals comprised in a colony, fifty or sixty only being the number assigned by Mr. Kent to *P. Häckeli*, whilst I have not met with any colony of *P. pedicellata* that did not contain a thousand or more.

I am indebted to Mr. Thomas for the drawing accompanying this paper (fig. 85), which is an attempt to represent the appearance of a moderate sized colony as viewed by a 2/3 in. objective with A eye-piece, but no drawing can give an adequate idea of the beauty of the organism when illuminated by the paraboloid and displaying its thousands of flagella in active vibration causing the entire colony to sail slowly about the field of view. Fig. 86 represents an individual monad very highly magnified showing the footstalk.

The collars are of course not seen in these circumstances, as they require a high power to observe them properly, but after having been seen and studied under a 1/16 they are easily recognized with a 1/4 in. or even a 2/3 under favourable circumstances of illumination. The mucilaginous zoocytium can only be seen with difficulty owing to its extreme transparency and freedom from foreign particles, and is best distinguished under black-ground illumination with a low power.

The shape of the colonies is usually more rounded than that of the specimen from which Mr. Thomas's drawing was taken, sometimes approaching a spherical form, but always presenting indications of having been attached to some other body. They probably grow on the stems of rushes, &c., but attached so slightly as to be easily displaced when the water is agitated by dipping a bottle, mouth downwards, amongst the rushes, moving it about a little and then suddenly reversing it, taking care not to stir up the mud from the bottom of the pond.

XV.—*On a New Form of Polarizing Prism.*

By C. D. Ahrens.

(*Read* 11*th June*, 1884.)

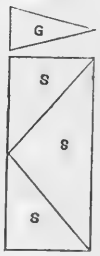
The prism which I desire to bring to the notice of the Society is intended for use either as a polarizer or an analyser. It will, I hope, be found especially useful as an analyser for the Microscope.

The employment of a Nicol prism above the eye-lens is subject to the great inconvenience that, owing to the necessary length of the prism, the eye of an observer is so far removed from the lens that a portion of the field is cut off. Double-image prisms of the usual construction are shorter, but they have another defect, viz. that the angular separation of the rays is so slight that the eye sees both images at once, and some confusion is thus caused.

My object in constructing this improved prism has been to obtain a much wider separation of the two beams of light; so that one of them, although not actually removed entirely by total reflection (as in the Nicol prism), is so far refracted to one side that it may be neglected altogether. I made several attempts to construct such a prism some years ago, but failed (as probably others have done) owing to the difficulty or impossibility of avoiding distortion and colour, and of obtaining a wide separation of the ordinary and extraordinary rays in a prism made up of only two pieces of Iceland spar.

I have now effected the desired object by making the prism of three wedges of spar cemented together by Canada balsam, as shown in the accompanying drawing (fig. 87). The optic axis in the two outer wedges is parallel to the refracting edge, while in the middle wedge it is perpendicular to the refracting edge, and lies in a plane bisecting the refracting angle. This disposition of the optic axis is the one originally suggested by Dr. Wollaston, and has the effect of causing a greater angular separation of the rays than Rochon's construction. By the employment of three prisms instead of two I am able to give the middle prism a very large angle, and yet to correct the deviation of the rays so far that on emergence they make approximately equal angles with the central line of the combination.

Fig. 87.

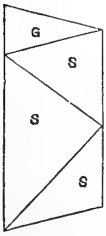


Nearly in contact with one of the terminal faces of the prism I place a prism of dense glass of such an angle that it just corrects the deviation of one of the rays and also achromatizes it, while it increases the deviation of the other ray to such an extent that it

may be practically disregarded altogether; an eye, even when placed almost close to the prism, receiving only the direct beam. This beam is, of course, perfectly polarized in one plane, and can by a proper arrangement of the glass compensator be rendered practically free from distortion and colour.

Other methods of effecting the compensation have suggested themselves in the course of my work, and I have obtained the best results by adopting the arrangement represented in fig. 88. In this, the glass compensating prism, instead of being mounted separately, is cemented upon one of the terminal faces of the compound spar-prism; the angle of this latter, and also of the other terminal face, being suitably modified.

FIG. 88.



This seems distinctly preferable to the original arrangement, for several reasons.

1. The total length of the compound prism is rather less, being scarcely more than twice its breadth.

2. The field is rather larger, so that the prism can be used over deeper Microscope eye-pieces (A and B) without any of the field of view being cut off.

3. The whole arrangement is more compact, all the components being firmly cemented together, and therefore not liable to accidental displacement.

4. There is less loss of light by reflection, the reflecting surfaces being reduced to two.

A ray of light entering the prism in a direction parallel to its axis is divided into two rays; one of which, on emergence, follows a course parallel to that of the original incident ray, and is practically free from distortion and colour: the other ray is deviated to the extent of about 59° 30′ (for yellow sodium light), being, of course, strongly coloured and distorted. The angular separation is so great that this latter ray does not interfere with ordinary observations.

I hope that the prism, which has cost me much time and labour, will meet with the approval of the Society, and take a place as a useful accessory to the Microscope and other optical instruments.

SUMMARY

OF CURRENT RESEARCHES RELATING TO

ZOOLOGY AND BOTANY

(*principally Invertebrata and Cryptogamia*),

MICROSCOPY, &c.,

INCLUDING ORIGINAL COMMUNICATIONS FROM FELLOWS AND OTHERS.*

ZOOLOGY.

A. GENERAL, including Embryology and Histology of the Vertebrata.

Polar Globules and other Elements eliminated from the Ovum.†—In this important contribution to the theory of sexuality, A. Sabatier sums up our knowledge as to the phenomena of spermatogenesis:—

A cellular element belonging to the so-called male gland (and not specially an epithelial cell) grows and acquires a thicker zone of protoplasm; this first differentiation gives rise to the primitive reproductive cell; this cell multiplies by division of the nucleus and of the protoplasm; the resulting agglomeration or group of cells is that which forms the male tubes of Pflüger, or the polyblasts. The first generation of cells (protospermoblasts) becomes more or less independent, and gives rise to one or more generations of protospermoblasts.

Later on, each cellular element, which is definitively male, acquires a thicker "atmosphere of protoplasm," while in the zone which is in direct contact with the nucleus there arise, by concentration and differentiation, that is to say by true genesis, homogeneous hyaline corpuscles, which undergo a further differentiation, and may multiply by simple division. These corpuscles, once formed, take a centrifugal direction, pass to the periphery of the cell, and become converted into spermatozoa. In this way is formed the deutopolyblast, at the surface of which the deutospermoblasts are eliminated.

* The Society are not to be considered responsible for the views of the authors of the papers referred to, nor for the manner in which those views may be expressed, the main object of this part of the Journal being to present a summary of the papers *as actually published*, so as to provide the Fellows with a guide to the additions made from time to time to the Library. Objections and corrections should therefore, for the most part, be addressed to the authors. (The Society are not intended to be denoted by the editorial "we.")

† Rev. Sci. Nat., iii. (1884) pp. 362–462.

The spermatozoa, which are derived from these last, obtain their nutriment from the nucleus or the protoplasm of the male cell. When completely developed they are detached, become free, and are capable of acting as male elements. The nucleus undergoes disaggregation.

Between the early history of spermatogenesis and oogenesis there is a remarkable resemblance, but there is a difference on which the author specially insists; in the female element the multiplication of the ovular elements is generally limited to an early period, so that the female tubes of Pflüger contain a proportionately small number of ovules, each of which is of a considerable size, while, on the other hand, the male cells undergo a relatively more numerous series of segmentations, and the resulting elements are large in number and small in size. The view of many authors that the fundamental process of spermatogenesis is a simple succession of cell-divisions, ending in the formation of a cell small enough to be a spermatozoon is erroneous.

The essential conditions of oogenesis are the following:—

A cellular element of the tissue of the ovary (not specially an epithelial cell) grows and acquires a more important layer of protoplasm; the nucleus multiplies more or less by division; each of the nuclei acquires an atmosphere of protoplasm, and we thus have the female tubes of Pflüger. The fundamental distinction only becomes apparent in the fourth stage, when the ovules, increasing in size, become differentiated by segregation and concentration, that is, by the formation of corpuscles, more or less hyaline, which make their way to the surface of the ovule. Here the essential difference commences, for in one case the centrifugal elements are developed and organized at the expense of the central element or nucleus, which is lost in the nourishment of the peripheral elements, in the other cases it is the centrifugal or peripheral element which is broken up or serves as food for the development of the central element, which then forms the egg.

From these facts it is clear that the two elements of different sexualities are the result of the elimination of one of them from a cellular body which at first possessed them both, and were, therefore, capable of a parthenogenetic mode of development.

The theory of sexuality put forward by Sabatier allows us, in his opinion, to understand how it is that one and the same sexual gland may, as in the ovotestis of hermaphrodite molluscs, give rise to both male and female elements, as well as such cases as those of *Bufo*, where one end of the organ is male and the other female; the theory applies likewise to the occasional hermaphroditism in Vertebrates, which, most pronounced in *Serranus*, has been noticed by various observers in other Vertebrates, and even in man (Heppner).

The sexual element is not always completely differentiated after a single elimination; two or even more may be necessary, and this is especially the case with the female. The sexuality of the reproductive cell is due to the appearance of the precocious globules or "globules de début"; though a cell which has suffered such an elimination is

truly an ovum, it is in many cases not completely so; later eliminations are often needed to complete the work.

The different kinds of globules given off from the egg-cell between the time when it is an asexual cell and a complete ovum are these:—

1. Precocious globules which generally form follicular elements, and which give, so to speak, the first impulse to the cell towards a sexual condition.

2. Globules which are more or less tardy in putting in an appearance, and which may be formed some time before or only just before maturity; like the first, they arise by a simple differentiation in the protoplasm, and not by karyokinesis; they are the "globules tardifs" properly so called.

3. There are globules which are cotemporaneous with the period of complete maturity, or the globules of perfect maturity. Most of these are due to phenomena of cell-division, and they are the polar globules properly so called.

The author thinks that it is an error into which all embryologists have fallen to regard the cellular nature of the polar globule as a point of capital importance; the principal, the necessary thing is the expulsion of a mass of protoplasmic substance which represents the male element; it is only an accident that it is effected by a cellular mode of segmentation. The essential fact is, in other words, the completion of a sexual polarity.

The lesson to be learnt from all the known facts may be thus summed up: Their common and very general character proves them to be of the highest value; they all point to an elimination, or a tendency to elimination, of a differentiated or undifferentiated portion of the central protoplasm, and they show that the concomitant phenomena are due to secondary circumstances which have no real importance on the significance of the globules or of the substances expelled by the egg.

Considerable support, even if not categorical demonstration of the validity of Sabatier's theory, is to be sought for in a comparative study of the method of oogenesis in animals which are both sexually and parthenogenetically reproductive; if the theory is applicable to the facts, we ought to find in parthenogenetic eggs either a complete absence of, or a relatively small number of eliminated elements, the number and presence of which in sexual cells ought, on the other hand, to be distinct and pronounced.

What observations (as yet few in number) the author has made on the history of the ova in Aphides seem to afford him the support he needs; still stronger support is given by Weismann's account of what obtains in the Daphnoidea.

In his historical survey Sabatier refers, of course, to the well-known views of Balfour, and points out that that embryologist looked upon the portion of the germinal vesicle which the polar globule contained as being the essential point in the sexuality of the egg, and he urges that the phenomena of karyokinesis are of no real importance;

we must, however, note that the author speaks of "les obscurités et les indécisions des idées de Balfour," and cannot refrain from suggesting that it is possible that the English naturalist has suffered in translation. In many points, Balfour's article, published in 1878, is in complete agreement with that now before us.

Sabatier tells us that his essay is to be looked upon as offering a rational explanation, which may be acceptable for the present, and promises a future essay on the relations of heredity to the sexual polarization of the elements.

Embryonic Germinal Layers and the Tissues.* — A. Kölliker states the conclusions of a valuable descriptive and critical essay in the following terms :—

1. In all multicellular organisms all the elements and tissues arise directly from the fertilized egg-cell and the first embryonic nucleus; and there is no such difference as is expressed by the terms archiblast and parablast.

2. The tissues first differentiated have the characters of epithelial tissues, and form the ectoblasts and endoblasts.

3. All the other tissues arise from these two cell-layers; they are either directly derived from them, or arise by the intermediation of a median layer, which, when developed, takes an important part in forming the tissues.

4. When the whole of the animal series is considered, each of the germinal layers is found to be, in certain creatures, capable of giving rise to at least three, and perhaps to all the tissues; the germinal layers cannot, therefore, be regarded as histologically primitive organs.

5. In birds and mammals there is no primitive organ for the formation of connective substance, blood, or vessels.

6. The elements of tissues already formed have, as it seems, the power of forming other tissues; those of the heterologous neoplasms are probably due to the remains of the embryonic cells or to elements similar in character to them.

7. There is no justification for the classification of the tissues as archiblastic and parablastic, but, on the other hand, the old division of the tissues under four primary types, as suggested by the author and by Leydig, is still the most appropriate.

Origin of the Mesoblast of Cartilaginous Fishes.†—C. K. Hoffmann commences his essay with the description of a developmental stage of *Pristiurus metabolicus*, which is a little later than Balfour's stage B. In this there is as yet no trace of the notochord, and the mesoblast is only beginning to be formed. There is still a distinct medullary groove, and the intestine is in course of formation.

The study of a number of sections, here described from before backwards, proves that the mesoderm forms a bilateral cellular layer, which grows forwards and backwards. Anteriorly it commences

* Zeitschr. f. Wiss. Zool., xl. (1884) pp. 179-213 (2 pls.).

† **Arch.** Neerland. Sci. Exact. et Nat., xviii. (1883) pp. 241-58 (2 pls.).

with the bilateral evagination of the primitive intestine, so that it arises by delamination. This mode of development appears, however, to obtain only during the period in which the intestine is not yet formed. When the intestine becomes a closed tube, the mesoderm is formed directly at the expense of a mass of indifferent cells; in other words, the endoderm and the mesoderm are intimately united at the point where the embryo is growing forwards. The part of the mesoderm formed by a process of delamination is, comparatively, very small. At the edges of the blastoderm and of the blastopore—the point where the embryo grows backwards—the three germinal layers are closely united.

The notochord is formed by the endoderm, and, like the mesoderm, it grows forwards and backwards. Anteriorly the layers are so closely united that the cord there appears to be solid, and the anterior portion of the notochordal groove is, therefore, only feebly developed. Posteriorly the delamination is very pronounced, and the groove is wide and deep. The animal portion of the endoderm, or that which gives rise to the notochord, is separated, on either side, by a narrow but distinct cleft from the intestinal endoderm. Anteriorly the notochordal and intestinal endoderm are completely fused, and directly continuous with one another; posteriorly they are for a long time independent. This would seem to show that the mesoderm originally arose, at the hinder extremity, by a bilateral delamination of the primitive intestine, and this has, in the course of phylogenetic development, been replaced by a process of folding.

The author applies his knowledge of the development of the cartilaginous fishes to an explanation of the phenomena of the development of the notochord and mesoderm in birds; and comes, in conclusion, to the result that the phenomena observed in the meroblastic ova of cartilaginous fishes amply demonstrate the truth that there is no well-marked division between mesoblast and mesenchyme, as has been insisted on by the brothers Hertwig. In these fishes only a small part of the median germinal layer is formed by the bilateral evagination of the primitive intestine—the mesoblast of the Hertwigs. The greater part of the layer would be, for the Hertwigs, mesenchyme. As a matter of fact, the two unite so early that it is impossible to say which had the earlier origin. The cells of the part which arise as mesenchyme have the same epithelial appearance as those which are formed by the evagination of the primitive intestine. The body-cavity—enterocœle—which was at first found only in the part of the median layer which arose by delamination, soon extends into the region which, from its mode of origin, should be called mesenchymal.

Intra-cellular Digestion in the Germinal Membrane of Vertebrates.*—J. Kollmann commences with an account of his observations on the cells of the endoblast in the lizard; these cells vary considerably in size, and in their protoplasmic contents one finds spheres which are to all appearance of a fatty nature, and which are also

* Recueil Zool. Suisse, i. (1884) pp. 259–90 (1 pl.).

present in large numbers in the fluid yolk; the nucleus of the endoblast-cells is most remarkable for the changes which it undergoes in position. The author was most struck by the cells which appeared to open superiorly, and took them at first for artificial products; observation, however, led him to conclude that this was a definite physiological stage, and that being so he is compelled to suppose that the endoblast-cells do not merely maintain existence by diffusion, but also by direct massive wandering; there would appear to be not only a completely mechanical intaking, but as complete an outgiving of yolk-spheres.

The author has also made some observations on the chick, and the result of his studies is his conviction that the cells of the endoblast take up food in an amœboid manner. He finds that ectoblastic cells have a similar power of incorporating yolk-material, which they do by means of amœboid movement. In *Lacerta agilis* he has observed protoplasmic processes directed towards the vitelline membrane, and has found in the interior of the cells small yolk-granules, and others which seemed to have been just incorporated.

In the acroblasts—as Kollmann terms the cells in the layer which lies between the ectoblast and endoblast—each of which is quite independent of the mesoblast, and in the cells derived therefrom which he calls "poreuten," a similar phenomenon has been observed. The latter are quite easy to find in the lizard, but are more difficult of detection in the chick, where they can only be seen after staining. In the lizard the author has been able to observe a direct movement of masses from the endoblast to the poreutes, a poreute sending out processes towards an endoblast-cell.

The author concludes with referring the reader especially to the work of Metschnikoff, in connection with which he would wish his own fragmentary contribution to be studied.

Larval Theory of the Origin of Cellular Tissue.*—A. Hyatt reviews the history of investigation among sponges; concluding that, though true Metazoa, they possess characteristics which show them to be derived from Protozoa. The parallel between the development of the cell and egg in the tissue is strictly parallel with the evolution of nucleated from unnucleated forms in Protozoa. Recent investigations have removed all objections to the homology of the egg or any cell with the adult of the nucleated protozoon; and the principal mode of reproduction by division is the same in all these forms. The egg builds up tissue by division after being fertilized by the male or spermatozoon, just as the spermatozoon builds up colonies after fertilization.

Spontaneous division of a cell which undergoes encystment takes place and the spermatozoa which result from this are true larval monads. These resemble the monads derived from division of the encysted bodies of Protozoa in their forms and in their activity. They differ in being able to fertilize the female or ovum at once,

* Science, iii. (1884) p. 337.

instead of being obliged to grow up to maturity before arriving at this stage.

Thus all cells may be regarded as larval Protozoa, and eggs and spermatocysts as encysted larval forms, the spermatozoa being equivalent also to larval forms which have inherited the tendencies of the mature forms in the Protozoa at the earliest stages. Thus the origin of the tissues in the Metazoa is in exact accord with the law of concentration and acceleration in heredity. The cells are larval, which, in accordance with this law, have inherited the characteristics and tendencies of their adult ancestors in their earliest stages. The three layers can be accounted for as larval characteristics inherited from colonies of Infusoria flagellata, which had two forms (protective and feeding zoons), and then three (protective, feeding, and supporting), these corresponding to ectoderm, endoderm, and mesoderm.

Development of Protovertebræ.*—H. Fol, from a number of experiments on the order of appearance of the protovertebræ of the common fowl, comes to the conclusion that "the first-formed somites of the body appear to be the most anterior of the whole series, and that they correspond, perhaps, to the cephalic region; the long series of protovertebræ are formed successively from before backwards." Thus the vertebrate embryo commences, so to speak, as a head only, the rest of the body appearing by degrees.

Experiments in Arrested Development.†—Another communication by M. Fol deals with some observations made by himself and S. Warynski which tend to confirm a previous discovery, that by momentarily heating the left side of an embryo chicken, a complete visceral inversion is obtained. The experiments consisted in pressing with the blade of a scalpel a portion of the embryo without injuring the vitelline membrane; by so doing, the development of that portion lying outside the line of pressure was completely stopped. The development of the left side of the embryo was hindered by separating it from the afferent portion of the vascular area, and it appears to be by an arrest of development of the left side that a visceral inversion is produced, "from which it may be concluded that this side ought to predominate to bring about the normal torsion."

Morphology of the Directive Corpuscles.‡—O. Bütschli points out that, for a satisfactory comprehension of the morphological significance of the directive corpuscle, it is necessary to bear in mind the mode of sexual reproduction in the colonial Volvocineæ, a group of the Flagellata, which not only by their structure, but also by the characters of their method of reproduction, approach most closely to the Metazoa, even though their mode of nutrition is vegetable in character. The simplest case of sexual reproduction has been made known to us by the researches of Pringsheim on *Pandorina*.

In it, at certain times, the cells of a colony give rise by successive

* Arch. Sci. Phys. et Nat., xi. (1884) p. 104.
† Ibid., p. 105.
‡ Biol. Centralbl., iv. (1884) pp. 5–12.

division to small sexual colonies, which arise in exactly the same way as the ordinary colonies which are merely formed by parthenogenetic reproduction. These small sexual colonies finally break up into the separate cell-individuals, which then copulate by pairs and form a resting zygote; a difference between the sexes of the separate individuals is not, or is only slightly, demonstrable. In the closely allied genera *Eudorina* and *Volvox* the facts are very different; in the former there appear at certain times colonies, which can be distinguished as male and female, some produce nothing but ova, others as distinctly give rise, after repeated division, to spermatozoa, which copulate with and fertilize the female colonies. In *Volvox* it seems possible to homologize the male and female colonies, and indeed we cannot here correctly speak of colonies, but ought rather to regard what are so called as multicellular individuals of the simplest kind, and we have in it the best marked intermediate stage towards the sexual reproduction of the Metazoa.

If we bear these facts in mind it is not difficult to suppose that the separation of a few small cells indicates the formation of a multicellular colony of "gametes" corresponding to the bundle of spermatozoa.

As to the physiological significance of the directive corpuscle we have to decide between the views of the author that we have here to do with an elimination of certain nuclear constituents of the egg-cell, and that of Minot, that it is an elimination of the male element. Against the latter we have the fact that in the simpler cases of sexual reproduction in plants, as the algæ, there is no process of elimination, such as is required by the hypothesis, and also the fact that it cannot be brought into accord with the known phenomena of parthenogenesis.

In a note the author states that the recent observations of Fol, Sabatier and others, only came to his knowledge after his essay was completed, and he has not yet had the opportunity to bring them into accord with his own views. He takes occasion, however, to refer to some observations lately made by his assistant, Dr. Blochmann, who has discovered a very remarkable mode of cell-multiplication in the ovarian ova of ants; these have certainly nothing to do with the formation of the cells of the follicle, for the ovum was already surrounded by a chorion, before the numerous small nuclei, which appear in an altogether unexplained way, had become developed. The observations of Blochmann on ants are possibly to be brought into association with phenomena observed in the ova of Myriopods and Tunicates.

Morphology of the Pineal Gland.*—F. Ahlborn has a short essay on the significance of the pineal gland, a subject which is of especial interest to English students on account of the recent hypothesis of Sir Richard Owen. The author comes to the conclusion that the pineal gland of vertebrates is to be regarded as the rudiment of an unpaired optic rudiment, and he bases this conclusion on the

* Zeitschr. f. Wiss. Zool., xl. (1884) pp. 331–7 (1 fig.).

similarity in the mode of its development and of the optic vesicle, that is, by a hollow outpushing of the central wall; on the origin and connection of the epiphysis with the optic region of the brain, and especially with the thalamus opticus; on the morphological resemblance between the organ and the primitive optic vesicle; on its almost peripheral position in Petromyzontes, Selachii, and Ganoids, as well as its completely peripheral position (outside the skull and at the same level with the eyes) in the Amphibia; and, finally, on the primitive connection, detected by Van Wijhe, between the epiphysis and the neural ridge.

The author, regarding the pineal gland as a frontal eye, thinks it justifiable to compare it with the unpaired eye of the Tunicata, and possibly also, of *Amphioxus*.

Segmentation of the Vertebrate Body.*—F. Ahlborn, after a résumé of the theory of Gegenbaur as to the composition of the vertebrate skull, points out that an advance was made when later investigators discovered evidence in favour of the mesomeres of the head; Götte, who was the first in this line of inquiry, recognized four segments in the cephalic region. The author's own observations on *Petromyzon* led him to the conclusion that the first two spinal nerves correspond to three mesomeres, and that the first neuromere nearly corresponds to the fourth and fifth mesomeres. From this it seems to follow that the first three myocommata were innervated not by a spinal but by a cerebral nerve; and that in the hinder part of the head of *Petromyzon* the parts of three true mesodermal segments are still retained. A further inquiry shows that the three first spinal nerves of Petromyzontes and of anurous Amphibia are completely homologous, and that the first cervical vertebra of the Amphibia corresponds to the fourth myocomma of the lampreys; if this result be correct it follows that the three first myomeres of the lampreys—which we have already recognized as typical cephalic segments—are homologous with the three hinder segments of the skull of the Anura. This remarkable agreement is further supported by the close systematic relation between these two groups which is spoken to by the large number of characteristics that they have in common.

Götte was followed by Balfour who attacked the problem by the road of the developmental history of the Elasmobranchii, and demonstrated the presence of a somatopleure and a splanchnopleure in the mesodermal elements of the head, as of the trunk; this considerable support to the doctrine of the metamerism of the head by the discovery of the head-cavities was succeeded by Marshall's investigations, which resulted in showing that metamerism first appeared in the ventral (or branchial) portion only, and by Van Wijhe's work along the lines of the same theories. The studies of the last-mentioned anatomist lead to the conviction that the mesomerism, which is independent of the branchiomerism, as Marshall proved for the anterior, is true for the whole of the cephalic tract; it is a

* Zeitschr. f. Wiss. Zool., xl. (1884) pp. 309–30.

typical segmentation which, primitively, completely agrees with the primary metamerism of the mesoblastic somites of the trunk. Of these cephalic somites there are nine. We may, in fine, conclude that the head of the Vertebrata ordinarily contains nine mesodermal segments, which, like the segmental musculature, might become of use to the specific cephalic organs; but the earlier stages generally disappear and the metameres are no longer clearly seen to be separate segments.

Ahlborn next addresses himself to the question of whether the gill-arches are homodynamous with the ribs, and comes to the conclusion that the history of development clearly shows that the metamerism of the gill-arches, which according to Gegenbaur's hypothesis is an expression of the primary mesomerism of the skull, is really nothing of the kind, but a segmentation which is caused by the primary branchiomerism of the enteron, and completely independent of the segmentation of the mesoderm. This conclusion is found to be confirmed by what obtains in *Petromyzon* and the Anura; the whole answer may be summed up in saying that the ribs are, but the gill-arches are not, segmental.

The other problem proposed is: How far have the cerebral and spinal nerves a segmental nature, of the kind supposed by Gegenbaur? No primary segmentation affects the nervous system. Neuromerism, therefore, is in the peripheral nervous system nothing more than a secondary repetition of all the pre-existing metameric phenomena in the body; it is segmental, when the nerves are distributed to the segments of the body, but not in the branchiomerous organs.

If the view be just that the nine rudimentary cephalic segments of the ancestor of the craniote Vertebrata were developed in just the same way as the trunk-segments, and if, at the same time, the medulla oblongata is a similar continuation of the spinal cord, we may conclude that there were primitively nine pairs of spinal nerves in the hind-brain, of which the third, fourth, and sixth had only motor roots. But at the same time the so-called spinal-like cerebral nerves of the Craniota cannot, when we consider their morphological and physiological significance and the secondary character of neuromerism, be any longer compared with the segmental pairs of spinal nerves.

Embryology of Alytes obstetricans.*—M. Heron-Royer, gives a detailed account of the external modifications observed during the embryonic development of *Alytes obstetricans*. For the purposes of observation the eggs were placed on moist muslin between watch-glasses, and kept exposed to light and to a warm temperature. The egg has a large vitellus and a small cicatrix. Segmentation, which is limited in extent, commences after 12 or 13 hours with a dorsal streak with a broad, shallow blastopore. The vitellus is now spherical, but soon becomes oblong with the formation of the elongated embryo. The embryo has paired ocular lobes anteriorly, and cor-

* Bull. Soc. Zool. France, 1883, pp. 417–436 (1 pl.).

responding branchial lobes posteriorly. In front of, and between, the anterior lobes is an air-bubble supposed to be respiratory in function. By the 3rd day the four lobes have increased and coalesced to form a "racket-shaped figure." During the 4th and 5th days the cranium and sense organs (excepting the eye) are developed, the olfactory organs appearing much later than in other Anura. The branchiæ appear as digitiform processes of the lateral masses. By the 6th day they are six in number on the right side and seven on the left. By the 7th day there are ten for each side. In addition there are tentacular ramifications which coil about beneath the walls of the ovum. M. Heron-Royer compares these (provisional) organs with the arborescent vascular processes described by M. Bavay in the developing ovum of *Hylodes Martinicencis*, and justly explains their origin by reference to the terrestrial conditions of the development of the young *Alytes*.

The heart, first observed on the 6th day, is covered merely by a pericardium, and not by the vitelline sac, as in other Anura. On the 8th day appears the abdominal investment, inclosing a portion of the disappearing vitellus, and distinguished therefrom by pigmentation. By the 9th day the yellow-coloured intestine is completely formed, and the vitellus absorbed. The eye is completed on the 13th day, when the choroidal fissure disappears, and the iris, hitherto white, finally assumes its metallic yellow colour.

On the 14th day the external branchiæ disappear, the right operculum being the last structure to be formed. The natatory membranes now develope, the caudal appendage elongates, and the embryo is ready to escape from the egg.

There are three investments to the egg: (1) an "external envelope," inclosing an albuminous layer; (2) an "inner capsule," oval in shape; and (3) the "chorion," directly investing the ovum proper, which is spherical.

M. Heron-Royer disagrees entirely with the previous observations on the mode of the escape of the embryo from the egg. He finds that the young *Alytes* does not (as de L'Isle and others had asserted) simply split the envelopes of the ovum, like a bean-pod; but rather that the exit of the embryo is at first conditioned by moisture. Exposed to moist conditions, the albuminous layer beneath the "external envelope" absorbs moisture and expands its investment. The "inner capsule" in the presence of the moisture becomes more supple and allows greater freedom of movement to the embryo, which now employs the external comb-like lamellæ on its jaws to effect an opening, first in the chorion, then in the 'inner capsule,' and finally in the "external envelope." Finally, bending its body into a bow, and fixing its tail against the capsule, the embryo, by a final effort, forces its way from the egg "comme un projectile." Sometimes the young *Alytes* sticks half-way or endeavours to emerge tail first, usually with fatal consequences.

M. Heron-Royer, by applying abnormal warmth and moisture, brought about the development of *Alytes* within 15 days. In normal circumstances, however, 24 days intervene between fecundation of

the ovum and the escape of the embryo, the male *Alytes* retiring with the eggs wound round its legs to holes in the ground away from light and warmth. On warm nights in July (with the thermometer at 20° C.) the male *Alytes* carries his charges down to the water, and they then effect their escape, as above described. If the atmospheric conditions are unfavourable the *Alytes*, guided by "son instinct barométrique," defers its passage from the land to the water.

Development of the Nervous System of Forella.*—An account is given by V. Rohon of his observations on the development of the cerebro-spinal system in the trout. Briefly summed up, his results are that the first nerve-cells, distinctly recognizable as such, occur in this fish in the *dorsal* (sensory) tracts of the cerebro-spinal system. These "cells of Reissner" are multipolar, lie on either side in a longitudinal series (6 to 8 pairs in a myomere at the time of escape of the embryo from the ovum), and occur in the spinal cord earlier than in the brain. In the spinal cord they have relations to the dorsal roots of the nerves of the same, and of the opposite side. These cells occur in much the same fashion in the adult trout.

Incubation of Eggs in Confined Air—Influence of Ventilation on Embryonic Development.†—C. Dareste describes the results of his experiments on the development of the embryos of fowls in a confined atmosphere.

The eggs were placed in a 12-litre incubator, all the apertures of which were kept closed for 21 days. When opened several eggs were found hatched, but the greater number had perished, owing to the development in the albumen of microscopic organisms. The organism most often met with was a plant similar to yeast.

In a second series of experiments the air was saturated with moisture, and in this case the albumen liquefied and leaked through the shell where it solidified in layers. This liquefaction appeared to be an obstacle to hatching; nevertheless, the embryos from the sound eggs had here also reached their full period, whilst those from the infected eggs had perished, stifled by a species of *Aspergillus* that developed a mycelium in the interior of the albumen, then formed green fructifications in the air-chamber, and finally on the walls of the shell.

The author concludes that air, modified by embryonic respiration, exercises no direct influence on the development and life of the embryo; but only an indirect one by facilitating the excessive development of the parasitic organisms. Hence the necessity of renewing the air of incubators. In the struggle for life between the embryo and the parasites the advantage is in favour of the former, if the air be renewed and is sufficiently dry; whilst in air that is stale or saturated with moisture the advantage is in favour of the parasitic organisms.

* SB. K. Akad. Wiss. Wien, 1884, pp. 39–56 (2 pls.).
† Comptes Rendus, xcviii. (1884) pp. 924–6.

B. INVERTEBRATA.

Effect of High Pressure on the Vitality of Micro-organisms.*—A. Certes describes some experiments which he has made on fresh-water and marine micro-organisms.

At a pressure of 100 to 300 atmospheres, maintained for 7, 24, 48, and 72 hours, some were killed; *Chlamydococcus pluvialis* were as lively as when they were put in the apparatus 7 hours previously; *Paramecium colpoda* and *Vorticellæ* (300 atmospheres for 48 hours) showed the "latent life" of Dr. Regnard.† The marine infusoria *Euplotes charon*, *E. patella*, and *Pleuronema marina* retained the power of motion, while *Holosticha flava* and *Actinophrys* were dead.

After 36 hours at a pressure of 520 atmospheres, the *Chlamydococci* were mostly in the latent state, the completely green individuals having resisted the pressure better than those which were turning red. Rotifers were taken out in full activity, while Tardigrades revived after a time.

In a case of bacteridian anthrax, blood submitted to a pressure of 600 for 24 hours maintained its full virulence.

Micro-organisms of the Deep Sea.‡—The researches of A. Certes on water and ooze from great depths tend to show that microbes that can live without air are absent from the bottom, while air-breathing forms are there present. The series of cultivation experiments which he carried on showed that the micro-organisms of deep-sea water were always much smaller and more active than those of the ooze. Ciliated or flagellate infusoria were absent. Successive cultivations resulted in the appearance of a number of large bacilli in active spore-formation. It has not yet been possible to decide whether the organisms found at great depths are identical with those already known.

The researches of Regnard have shown that soluble ferments are not affected by pressure; under the influence of 1000 atmospheres starch was converted into sugar under the action of saliva. The other results obtained have been already noted.§

Origin and Formation of Glairine or Barégine.‖—Supplementing a former paper on this subject, N. Joly describes the result of his observations on the origin and mode of formation of glairine or barégine in the sulphurous thermal waters of the Pyrenees. Microscopical examination, with a low power, of glairine and "sulfuraire" in the course of formation revealed the presence of a very considerable number of animalcules, *Naïs*, *Cyclops*, &c., in the full vigour of

* Journ. de Microgr., viii. (1884) pp. 291–3.
† See this Journal, *ante*, p. 362.
‡ Naturforscher, xvii. (1884) pp. 193–4.
§ See this Journal, *ante*, p. 362.
‖ Mém. Acad. Sci. Toulouse, v. (1883) pp. 118–25 (1 pl.).

life, and this though the temperature of the water reaches 40° C. to 49° C. By their death and decomposition they furnish to the water the nitrogenous organic material which it holds in solution, and the gradual transformation of their remains into glairine precisely similar to that formerly observed is described by the author, who concludes that the concrete glairine of chemists is a complex substance, into the composition of which enters as a primordial element, a vast amount of animal and vegetable detritus. The "sulfuraire" is a very different production, but its fragments and those of various inorganic substances go to swell the mass of the glairine.

In a note to the paper is given a list of the organized bodies, to the number of 39, that have been recorded as occurring in sulphurous waters; whilst figures of *Naïs sulfuræa* and *Cyclops Dumasti* are given in the plate.

Organisms in Hail-stones.*—Boyd Moss has, on two or three occasions during the last twelvemonth, collected a few hailstones in a conical glass, so that anything contained in them subsided to the bottom as they melted, and has always found organized remains, but he never had any idea of the quantity of these till a recent hail-storm. He figures the contents of a single hailstone (about 1/4 in. in diameter), which he placed, with every precaution as to cleanliness, between the glasses of a live-box. These consisted of diatoms, a living *Amœba*, a spore, probably of fungus, pale yellowish bodies like ova about 3 to 4 times the diameter of a human red blood-corpuscle (at least 40 of these), and a dark brown mass with small bright spherules. The *Amœba* and one diatom were in active movement. The spore (?) he calls the attention of microscopists to, and would be glad to hear if they are acquainted with it, "as it is one of several of the same kind which he discovered among the fibres of the heart of animals dead from cattle disease in India in 1870, and described in the 'Monthly Microscopical Journal' for December of that year, p. 312."

Mollusca.

Suckers of Sepiola.†—M. Niemiec describes the structure of the suckers of *Sepiola rondeletii*. The general features appear to agree pretty closely with the account given by P. Girod of the suckers of other Cephalopods,‡ but present some special peculiarities.

The sucker consists of three parts: (1) the basal portion imbedded in the subepithelial tissues of the arm; (2) the peduncle; (3) the sucker proper. The basal portion is surrounded by a layer of annular muscles; within this is a longitudinal layer, while the centre is occupied by a series of radiately arranged fibres. These three layers are continued into the peduncle, and in the short arms terminate in the piston of the sucker, while in the two long arms they are inserted into a rounded cartilage. In other respects the suckers upon the

* Knowledge, v. (1884) p. 423 (1 fig.).
† Arch. Sci. Phys. et Nat., xi. (1884) pp. 100–2.
‡ See this Journal, iii. (1883) p. 636.

short arms differ from those upon the long arms, the main difference being that, while the former are furnished with muscles directly continuous with those of the peduncle, the latter contain no muscles at all, but only a mass of parenchymatous tissue between the two epithelial layers.

Histology of the Digestive System of Helix.*—From a study of *H. pomatia* var. *grandis*, Dr. F. Bonardi, who has made frequent use of double-staining methods, finds five distinct layers in the wall of the buccal mass, viz. (1) The outermost, of connective tissue, consisting of a fibrillated basis and of nuclei, and of a few distinct cells, which often contain calcareous concretions and refractive fatty globules; and next to it (2) muscular, in two layers, the outer longitudinal, the inner circular. They form an exception to the characters of the muscles in this animal, in often being in appearance transversely striated; this is, however, probably only owing to a peculiarity in the arrangement of the fibres within the sarcolemma. (3) Connective tissue, a continuation of the tunica connectiva of the other parts of the digestive system, containing granular cells. (4) Cylindrical epithelium, the cells very long; over the prominence described by Semper in the upper and lower parts of the buccal cavity it is ciliated. (5) Cuticula, of considerable thickness; it is stratified in a longitudinal direction, and some large striæ placed perpendicularly to the surface of the epithelium perhaps represent fine canals. The tongue consists chiefly of a muscular mass; this includes three distinct muscles, two of which are symmetrical and posteriorly separate, so as to embrace the lingual papilla; the third lies transversely below and unites them in the median and hinder parts of the tongue. All are isolated by connective tissue. The surface of the tongue is divided up by two sets of grooves into quadrangular spaces, on which are placed a large number of whitish pyriform papillæ. The lingual papilla (at the base of the tongue) is covered by connective tissue, beneath which lies a layer of circular muscular fibres, covering a very distinct tunica connectiva, apparently not hitherto observed, containing oval cells with distinct outlines, imbedded in granular matter. It lies next to the cylindrical epithelium of the radula.

The centre of the papilla consists of a transparent colourless substance, the external parts of which, near the radula, have the structure of connective tissue. The other parts contain fibrils going in various directions. At certain points they are inflated and have nuclei. They make up the "legs of the papilla," and become mingled with the lateral muscles of the tongue. The alimentary canal (viz. the œsophagus to the end of the duodenum) has (1) an external connective coat corresponding to the peritoneum of the higher animals, underlaid by (2) double muscular, and (3) a connective layer corresponding to the vertebrate *mucosa*, and (4) an epithelial layer covered by a cuticula. The muscular fibres are not striated; those of the one layer are longitudinal, of the other transverse, some

* Atti Accad. Sci. Torino, xix. (1883) pp. 33-46 (1 pl.).

being oblique. The connective layer (3) has a lacunar structure. The lacunæ are lined by a cylindrical endothelium. The epithelium lining the depressions of the stomach, &c., may be said to be glandular; that occurring over certain conical processes of the connective layer is absorptive. From the distribution of the glandular and absorptive organs, Dr. Bonardi is led to abandon the terms œsophagus, stomach, and duodenum as expressing physiological facts. With the exception of the buccal portion, which is used for prehension, and the extreme posterior section, acting as an expelling organ, no separate functions are assignable to any part of the canal. The wall of the duct of the salivary glands consists of an outer cellular connective layer continued from the different glandules, of a median muscular coat comprising circular and oblique fibres, and of an epithelium made up of small cylindrical cells, on which no cilia were found. The refractive granules in the cells of the inner surface of the hepatic lobules are considered, with Barfurth, to be calcareous, but the "ferment-cells" described by that author were not made out. Numerous muscular fibres were found in the peritoneum of the liver.

Aplysiæ of the Gulf of Naples.*—F. Blochmann distinguishes three species of *Aplysia* in the Gulf of Naples by the following characters:—

I. Lateral lobes free as far as the foot. A fine canal leads into the cavity which contains the shell. Behind the genital opening is a racemose gland.
   Animal 20–80 cm. long; black, with white and grey spots. *Aplysia limacina* L.

II. Lateral lobes fused together as far as the siphon. A wide hole without folded margins leads into the cavity which contains the shell. Behind the genital opening a group of unicellular glands, each of which has a separate external pore.
   a. Animal 10–20 cm. long; clear reddish to blackish brown, white spots, the margins of which coalesce. The upper side of mantle has no cilia. *Aplysia depilans* L.
   b. Animal 7–15 cm. long; same colour as the last, the spots, however, smaller, and distinct, with usually a black border. Upper side of the mantle ciliated. *Aplysia punctata* Cuv.

The paper contains further details of the anatomy of these three species, a complete list of synonyms, and a bibliography of the subject.

Morphology of the Acephalous Mollusca.†—H. de Lacaze-Duthiers devotes his first memoir on the 'Morphologie des Acéphales,' to the remarkable *Aspergillum* (*A. dichotomum*) or Watering-pot Mollusc, the animal of which is so rare, though the well-known shell is

* MT. Zool. Stat. Neapel, v. (1884) pp. 28–49 (1 pl.).
† Arch. Zool. Expér. et Gén., i. (1883) pp. 665-732 (5 pls.).

common enough. After an account of the difficulties which he personally suffered in trying to get these molluscs for dissection, and a discussion of its general characters, the author describes the structure of the shell, in which he distinguishes the true from the false shell. The former, as is well known, consists of two small valves, and possibly also of zones which extend beyond their limits; the latter is tubular in form, and presents differences in sections taken at different points. In the terminal or lower part the calcareous tissue is pretty compact, and is formed of a number of layers which can be easily separated from one another, and do, as a fact, so easily part that it is impossible to make a satisfactory circular section of the tube. The facts of structure seem to show that the secretion of the false shell and its mode of growth depend on a deposit of crystalline particles, which, when effected slowly, gives rise to spheres, and when rapidly, to needle-shaped bodies. With regard to the marks or lines of attachment of the muscles, which are so prominent a feature in the shells of ordinary Lamellibranchs, it is here difficult to speak with certainty, and such lines of insertion as can be made out are hard to describe, inasmuch as they vary in depth in different individuals, and have not always exactly the same contour.

To examine the animal that forms the shell it is necessary to break the latter, for it is impossible to extract by the lower orifice a conical body, in which the base has, of course, a longer diameter than its truncated apex. The body has a chitinous envelope which is probably, though not quite certainly, secreted by the mantle; this last has no remarkable characteristics. The description of the mantle is followed by a general account of the structure of the animal, and the author then passes to the digestive tube.

The dissection of the digestive tube was long and laborious on account of the intimate relations of the genital and hepatic glands; as in other Lamellibranchs it describes a convoluted or apparently capricious course. The form of the anus is remarkable in consequence of its being affected by a constriction quite close to the end of the rectum; the extremity has the form of a small spherule, and the orifice is bilabiate. Within the interior of the intestine there is a projection comparable to the typhlosole of the earthworm; in the stomach the same ingrowth has a number of folds. No cæcum or hyaline style was to be observed. The œsophagus is certainly much longer in *Aspergillum* than in any other Lamellibranch; the mouth is very easy to find, and appears to have a definite relation to the superior orifice of the disk of the mantle. The liver, as in all its allies, is well developed; though the condition of his specimens did not enable the author to make altogether satisfactory preparations, he thinks that it agrees in essential characters with that of other Lamellibranchs.

The organ of Bojanus is heart-shaped in form and brownish in colour; the pericardiac orifices are relatively easy to find, and, as in *Anodon*, the external orifices are situated at a high level. It is, without doubt, the organ that was described by Rüppell as the liver.

The central organs of circulation closely resemble those of other

Lamellibranchs, and the general plan of the vessels would seem to be on the same type.

The gills are simple in structure and conform to the Lamellibranch type. The generative glands are united in the same individual; the acini of the testis are large, smooth, or polyhedral, the ovary is also racemose in form, and is placed behind the male organ. After a description of the nervous system and of the muscles, M. de Lacaze-Duthiers sums up the substance of his observations by pointing out that the animal of the watering pot shell is morphologically altogether like that of any other Lamellibranch. After an early period in which development goes on quite regularly, the body, owing to the excessive growth of its lower portion and the stationary condition of the upper, can no longer be withdrawn into its shell; then there commences a period of abnormal calcareous secretion, which gives rise to the peculiar form of the "shell." But this remarkable phenomenon does not affect the essential characters of the animal, which is much more truly lamellibranch than *Tridacna*, *Anomia*, or the oyster.

In conclusion, the author insists on the value of commencing the study of any given group by the consideration of the anatomy of a normal form.

Molluscoida.

Anatomy of Rhopalæa.*—L. Roule describes the structure of this simple Ascidian, which is very abundant in the neighbourhood of Marseilles. The body is divided into two halves, of which the anterior is triangular and free, while the posterior is irregular in form and fixed; the two halves are united by a delicate region of some length. The tunic, in its hinder portion, contains a number of vacuolated cells, which are absent from the anterior. By its general facies *Rhopalœa* resembles the Clavelinidæ, but its structure and mode of development associates it with the Phalusiidæ; and it may be considered as forming a link between the simple and compound Ascidians. In some points, such as the postbranchial position of the viscera, it approaches *Ciona* more than the true *Phallusiæ*, with which, on the other hand, it agrees by the possession of longitudinal folds in the wall of the branchia. Its affinities may be said to be numerous, and to form a bond of union between several diverse groups.

Arthropoda.

a. Insecta.

Luciola italica.†— C. Emery, after some observations on the external characters of these insects, and the differences between the males and the females, in which he points out that in the male the whole of the lower of the penultimate (fifth) and last abdominal segments is phosphorescent, while in the female, which has seven abdominal segments, only two spots at the sides of the lower surface are luminous, passes to the structure of the luminous organs, in which there are the following, among other, interesting points. Prepara-

* Comptes Rendus, xcviii. (1884) pp. 1294–6.

† Zeitschr. f. Wiss. Zool., xl. (1884) pp. 338–55 (1 pl.).

tions made with osmic acid showed that the smooth terminal branches of the tracheæ always end freely, and that they are never connected with other capillaries, either of their own or of other trunks; the author is so certain of this that he thinks that the anastomoses observed by Kölliker and others in the Lampyridæ can have no real existence. The structure of the dorsal layer of the luminous plates is very simple, no distinct cellular elements could be isolated, and the organs whether fresh, or after treatment with various reagents, showed nothing but opaque uric concretions floating in large numbers in the fluid.

On comparing the luminous plates of *Luciola* with the light-giving organs of other Lampyridæ we are able to compare the clear cellular elements of the cylindrical lobules, which surround the vertical tracheal limbs and their branches, with the terminal tracheal cells described by M. Schultze.

In *Luciola* the arrangement and distribution of the elements is much more regular than in other forms, and the plates appear to have attained to a much higher and more complete grade of development, as is expressed by the regular structure of the lobes, and by the special development of the tracheal end-cells, as well as by the constant dichotomous division of the termination of the tracheæ.

The author discusses the homodynamy of the luminous organs with portions of the fat-body, and finds powerful evidence in support of it in the complete agreement in form, size, and relation to reagents exhibited by the nuclei of the luminous organs on the one hand, and of the fat-body on the other. With regard to the loss of substance by *Luciolæ*, Emery's observations lead to the conclusion that a luminous and flying specimen loses daily about half a milligram in weight; it is to be borne in mind that the *imagines* eat nothing.

In conclusion, the physiology of the luminous activity is discussed. The males are either luminous for short and regular periods, or, when seized or injured, are without intermission, though not so remarkably, brilliant. In the latter case, which, it is clear, is the only one on which observations can be made, bright rings are seen on a dark background, and it would appear that the luminous oxidation takes place at the surface of, but outside the substance of the parenchymatous cells. These appear to secrete the luminous material, which is taken up by the tracheal end-cells, and burnt by means of the oxygen in the fine branches of the tracheæ. This combustion can only take place when the chitinous membrane of the tracheæ is extraordinarily fine.

The author does not think that this luminous power is a sexual means of exciting the rare females, but rather that it is a kind of warning to insectivorous nocturnal animals; the unpleasant smell which a *Luciola* gives off on injury makes it perhaps disagreeable to bats or other nocturnal animals.

Development of Œcanthus niveus and its parasitic Teleas.*—H. Ayers finds that the ovum of *Œcanthus*—the tree-cricket—arises

* Amer. Nat, xviii. (1884) pp. 537-40; from Proc. Boston Soc. Nat. Hist., 1884, 56 pp. (8 pls.).

from a germarium, and not from an ovarian epithelium; and that the yolk is formed by cell-degeneration and not by secretion. The embryo exhibits a primitive segmentation, before the appearance of the permanent segments, each of which bears a pair of appendages, though some are rudimentary and deciduous. The dorsal vessel arises as a paired organ, the lateral halves of which give rise, by fusion, to a median tube, just as in some Vermes; the blood-corpuscles are the nucleoli of endodermic cells. A rather startling discovery is that of the gills, which Ayers describes as a pair of lateral outgrowths derived from the ectoderm of the pleural region of the first abdominal segment; the gill-cavities are continuous with the body-cavity, and they appear to serve as channels through which the vascular fluid circulates. "The gill-pad is essentially a single-layered sac, with a much-constricted neck, evaginated from the pleural region of the abdomen"; they are not tracheate gills, for they contain no nuclei.

The author failed to observe any sharp distinction between a cell and its nucleus, or between a nucleus and a nucleolus; but he was able to detect the existence of segmental enlargements of the mesodermic somites, similar to those from which the nephridia of worms take their origin.

The author discusses the origin and function of the embryonic membranes (amnion and serosa), and points out that an answer is impossible if we do not clearly comprehend the relations of the embryo to its nutriment and food-yolk. They can hardly be supposed to have been primitively protective in function, and the egg is furnished with a protecting membrane (the chorion) before it leaves the body of its parent. Ayers comes to the conclusion that the serosa functions as a yolk-sac, while the amnion is the dorsal wall of the insect. It is to be noted that in *Limulus* the serosa does become a "vicarious chorion" (Packard), and after the splitting of the true chorion, forms a protective membrane.

The egg-parasite *Teleas* appears to be remarkable for the absence of embryonic membranes, and to give rise to a "larval form intermediate between the blastosphere and the cyclops-larva of Ganin."

Origin of Bees' Cells.*—Dr. Dönhoff urges objections to the views of Buffon, carried further by Müllenhoff, that bees' cells are due to pressure, pointing out that there is no relation between the forms of the cells and of the bees' bodies, and that he has observed a single female build a nest consisting of a number of six-sided cells; further, the difference seen in cells formed by bees and drones cannot be correlated with any differences to be found in the inhabitants; in the formation of the queens' cells by other bees there is no pressure to produce the rhomboid pits; direct observation of the formation of a comb was not rewarded by any indications of pressure; no reasonable amount of pressure on the walls of cells seems to have any effect in altering their form.

The author thinks that Darwin has erred in supposing that the cells

* Arch. f. Anat. u. Physiol., 1884, Physiol. Abth., pp. 153–5.

have at first the forms which they have later on, whereas this is by no means the case; at first there are nothing but rhomb-shaped spaces, the size of which is gradually increased.

Closed Poison-glands of Caterpillars.*—Dr. Dimmock states that if a *Cecropia* caterpillar "be examined carefully, the black spines upon its red, blue, and yellow knobs, or tubercles, will be seen to break easily from the tubercles, and a clear yellow fluid of disagreeable odour to ooze from each opening left by the injury. By crushing the tubercles with a pair of forceps the same strong odour is very noticeable, and by this mode of treatment one has no difficulty in proving that each tubercle, small or large, blue, yellow, or red, contains the odorous fluid. The red tubercles are seen, in sections cut with the microtome, to be divided into compartments, the cavities of each spine opening into a compartment at its basal end. The spines themselves are quite rigid and very brittle, so that they break away at a slight touch and leave a hole in the tubercle, out of which the odorous fluid pours, pushed by internal pressure. This fluid, which I have not examined carefully, but which I hope later to study chemically, is strongly acid to litmus paper, but causes a purple precipitate in carmine solution." The odour given out by these glands suggests at once their protective function. Similar glands, i. e. with no outlet until one is produced by external agency, are not rare in Bombycid larvæ. Karsten, in 1848, described the anatomy of the poison-glands at the base of the hairs of an American *Saturnia*. The secretion is "perhaps formic acid or a formate in solution."

Gills of Insect Larvæ.†—G. Macloskie states that it is usual to describe the laminæ of the pneumatic gills as containing systems of fine tracheal loops, somewhat after the pattern of a plurality of carbon-wicks in an Edison lamp. In a specimen, however, of the rectal branchiæ of the larval *Libellula*, which he rolled under the cover-glass, he found that the multitude of tracheal ramifications ended cæcally; all were of about the same length, their extremities recurved within the containing sac, and their tips not all swollen, but rounded off. "As they are elastic, and the closing sac distensible, we ‡ think it highly probable that with each water-inspiration the sacs enlarge and the tracheal spray (having air forced in by the forward compression of the large tracheæ) spreads out so as to bring the full tide of air close to the tide of water. Léon Dufour seems to have had some process like this in view, when he said that each lamella of the branchia of *Potamophilus* 'is probably swollen during life by air transmitted by endosmosis.' As we understand the case, the air is injected into the branchiæ from the rest of the body by rhythmical contractions, and its gases then communicate endosmotically with those in the tidal waters, so as to secure renovation." The action of the tracheæ, Macloskie believes to be tidal rather than due to peripheral capillary circulation; there being a flux and reflux, rather than a mere circulation of the air.

* Psyche, 1882 (4). Amer. Natural., xviii. (1884) p. 535.
† Psyche, iv. (1883) pp. 110-2. ‡ Amer. Natural., xviii. (1884) pp. 534-5.

Dangers from the Excrement of Flies.*—B. Grassi describes experiments which show that flies are agents in the diffusion of infectious maladies, epidemics, and even parasitic diseases.

On a plate on the table of his laboratory he placed a large number of the eggs of a human Nematode parasite (*Trichocephalus*). After a few hours he found, on some white sheets of paper hanging in the kitchen, the well-known spots produced by the excreta of the flies, and on a microscopical examination of these spots, several of the eggs of the parasite were found in them. Some flies coming into the kitchen were now caught, and their intestinal tract was found quite filled with an enormous mass of fæcal matter, in which the presence of eggs of *Trichocephali* were detected. As it was practically impossible to keep all alimentary substances from contact with these flies, it follows that the chances of Dr. Grassi and his family being infected with *Trichocephali* were very great. As a matter of fact, the experiment was tried with non-segmented eggs of this worm. Another experiment was in the same direction. Dr. Grassi took the ripe segments of a *Tænia solium* (which had been in spirits of wine) and broke them up in water, so that a great number of the tapeworm's eggs remained suspended in the fluid. The flies came to the mixture, attracted by the sugar, and in about half an hour the ova of the tapeworms were to be found in their intestines and in the spots. Had these eggs been in a recent and living state, they would doubtless have been just as easily transported. To those who care to try these experiments, it is suggested that lycopod powder mixed with sugar and water is a good material, as the lycopod spores are easily detected.

It is self-evident that if the mouth-apparatus of the fly will admit of the introduction of such objects as have been above noted, that there will be no difficulty in its admitting scores of the spores of many parasitic fungi, and above all of those belonging to the Schizomycetes, the possible cause of so much disease. Already Dr. Grassi has detected in fly excrement the spores of *Oidium lactis*, and the spores of a *Botrytis*, this latter taken from the bodies of silkworms dead of muscardine.

There arises, of course, the question of how far the active digestion of the intestines of the flies may not destroy the vitality of germs or spores thus taken in, but it would seem probable that in many instances the larger bodies swallowed may not serve as objects for assimilation, but may be got rid of as foreign bodies, and it will be borne in mind that the flies themselves fall victims to the growth of a parasitic fungus (*Empusa muscæ* Cohn), which is probably taken first into their own stomachs.

β. Myriopoda.

Nerve-terminations on Antennæ of Chilognatha.†—A preliminary note upon these structures is contributed by O. Bütschli; the results were worked out by Dr. B. Sacepine in conjunction with Dr. Bütschli, but having been left in an incomplete condition, a brief *résumé* of the more important new facts seemed desirable.

* Arch. Ital. Biol., iv. (1883). See Nature, xxix. (1884) pp. 482–3.
† Biol. Centralbl., iv. (1884) pp. 113–6 (2 figs.).

Previous observers have noted the occurrence of conspicuous structures upon the antennæ of Chilognatha, which correspond to the so-called olfactory cylinders of insects recently studied in detail by Hauser,* and between the two there seems to be a general similarity.

Each of the sensory processes is entered by a nerve which immediately divides into two branches, each covered with ganglionic cells which are distributed in two groups, the anterior one consisting of considerably smaller cells than the posterior ones; at the distal extremity the nerve-fibres again collect into a bundle and form the termination of the organ; that these fibres are differently constituted from those which enter the ganglion below is shown by the fact that their behaviour to staining reagents is different; the sensory process is often at the free extremity so that a direct communication is established between these nerve-endings and the outer world.

A structure essentially similar to this is found in *Vespa*, but is differently construed by Hauser; according to him the posterior group of cells is not present since he only figures one nucleus, *with several nucleoli* however, while the anterior group of smaller cells has escaped his attention; accordingly the conclusion to which Hauser has arrived at is that the whole sensory structure is a single cell; whereas in reality it consists of a great number of cells.

Ovum of Geophili.†—E. G. Balbiani records some observations made on the development of the germinal vesicle and the follicular cells of the ovum in *Geophilus*. In the fresh ovum the germinal vesicle is spherical; when treated with dilute acetic acid a funnel-shaped hollow process is seen to arise from the germinal vesicle; one end of this is in close connection with the germinal spot and a process of the latter can be observed to penetrate the cavity of the funnel. It is covered externally by a delicate layer of vitelline protoplasm. In adult females this "nuclear appendix" has the form of a long coiled thread, sometimes it is represented by a number of variously sized cylindrical masses, at other times by several round bodies scattered through the substance of the vitellus; the latter conditions are evidently the result of a division of the coiled thread-like nuclear appendix, but the division is never complete inasmuch as a considerable portion always remains adherent to the germinal vesicle. Each of these small round bodies into which the nuclear appendix splits up contains all the elements which go to form the ovum, viz. a portion of the germinal vesicle, the germinal spot, and the vitelline protoplasm. The wall of the follicle which incloses the ova is seen to contain a number of small cells which agree in every respect with these small cellular bodies resulting from the division of the nuclear appendix, and the view that they originate from the latter is confirmed by the recent investigations of MM. Fol, Roule, and Sabatier on the ovum of Ascidians. The follicular cells appear therefore to be the homologues of the spermatoblasts in the male, and the "vitelline nucleus" also corresponds to one of the same.

* Zeitschr. f. Wiss. Zool., xxxiv. (1880) p. 367.

† Zool. Anzeig., vi. (1883) pp. 658–62 (7 figs.), 676–80 (3 figs.).

γ. Arachnida.

Poison Apparatus and Poison of Scorpions.*—J. Joyeux-Laffuie, from his own studies and a consideration of what has been discovered by other naturalists, comes to the conclusion that the poison-organ of the scorpion (*S. occitanus*) is formed by the sixth or last somite of the post-abdomen, which terminates by a sharp process, at the extremity and sides of which are two oval orifices by which the poison escapes. There are two secreting glands, each of which opens by an excretory duct to the exterior. Each gland is situated in a cavity, which it completely fills, and which is formed by the chitinous skeleton and by an enveloping layer, formed by striated muscular fibres; it is by the contraction of this latter that the poison is forced out. The gland has a central cavity which acts as a kind of reservoir, and a proper wall, which is formed of a layer of cells that send out prolongations into the cavity, and of a layer of epithelial cells, which, in the fresh condition, have a finely granulated protoplasm; these are the secreting cells. The poison is very active, and, even in weak doses, soon kills most animals, and especially arthropods or vertebrates. The phenomena of poisoning are always the same, and take place in the following order—(*a*) pain at the point of injury; (*b*) period of excitement; (*c*) period of paralysis. The convulsions which are characteristic of the second stage, are due to the action of the poison on the nervous centres, and especially on the brain; the paralytic phenomena are caused by the action of the poison on the peripheral extremities of the motor nerves, where they appear to have the same influence as curare. The muscles, the heart, and the blood are in no way attacked, and the poison may therefore be certainly placed among those which act on the nervous system. The scorpions found in France (*S. europæus* and *S. occitanus*) cannot cause the death of a human subject, and are only dangerous when several poison a man at the same time, or attack very young children. To judge by his bibliography, the author is unacquainted with the observations on the habits of scorpions, published in 1882 by Prof. Lankester. †

Structure and Function of the Liver of Spiders.‡—P. Bertkau finds that the so-called liver of spiders arises by the development of a considerable number of diverticula of different sizes from the widened portion of that region of the intestine which is found in the abdomen; as these branch more and more they become united into a continuous whole by the formation of an intermediate tissue. Of the entire diverticula five are larger than the rest, and they are, like the intestine at their point of origin, glandular in nature. The epithelial cells are either small and oviform, closely packed with large colourless spheres, or they are larger and club-shaped, when part of their contents consists of small crystals and larger drops, which are yellow, brown, or green in colour. The chief function of the secretion of these glandular cells is the breaking up and altera-

* Arch. Zool. Expér. et Gén., i. (1883) pp. 733-83 (1 pl.).
† See this Journal, ii. (1882) p. 612.
‡ Arch. f. Mikr. Anat., xxiii. (1884) pp. 214-45 (1 pl.).

tion of fibrin and other albuminous bodies. Spiders do not take in food in the solid form; they dissolve the muscles, &c., of their prey, and suck in the fluid food; this passes into the final branches of the enteric diverticula.

The hind-gut commences just behind the last pair of these diverticula. The Malpighian vessels ramify in the intermediate tissue, and secrete guanin or an allied substance. This body may be found deposited in the outer layer of the intermediate tissue, and it takes a considerable share in the coloration and marking of the animal. On the whole, it would be well, in the present state of our knowledge, to substitute for the name "liver" that of "chyle-stomach."

In the substance of the organ itself we may distinguish more or less regular hemispheres of various shades, an almost completely transparent tissue, and a system of fine richly branched Malpighian canals; these last have fine canals which pass into wider collecting ducts, which open into a wide cloaca; the walls of this have a distinct muscular investment, formed by an outer layer of longitudinally and an inner of transversely disposed fibres.

The author gives some account of the differences which the cæcal diverticula present in various genera of spiders and in forms allied to them.

Anatomy of Acarina.*—J. MacLeod, in a preliminary notice, states that, in his investigation of the Acarina, he has made use of sections, after hardening in picrosulphuric acid or alcohol, and staining with carmine, but that the successful results seem to have been greatly due to chance, specimens collected at the same time and treated in exactly the same way behaving very differently on treatment with hardening and staining reagents. The genera examined were *Trombidium*, *Argas*, *Hydrachna*, and *Gamasus*.

He finds that the tracheiform excretory ducts of the salivary glands open separately into the labial groove at a short distance in front of the buccal orifice. The description given by Henking as to the presence of short narrow ducts arising from tubular glands is confirmed. The suctorial apparatus of *Argas* differs completely from that of *Trombidium*, accurately described by Henking; it has three branches, each of which is bifurcated, and is provided with three radiating muscles. Notwithstanding the difference in their structure the two organs seem to obey the same dynamical laws.

The author has been able to definitely assure himself of the communication between the stomach and the terminal intestine, which, denied by most authors, has only been regarded by Henking as probable on *à priori* grounds. The communication is effected by a pair of lateral orifices, which are extremely narrow, and have their lips almost always closely applied to one another; the difficulty of detecting them is increased by the presence of a large number of almost villiform cells which are found around them.

The terminal intestine is filled by a granular substance, which is composed of brownish-yellow granulations similar to those that are

* Bull. Acad. R. Sci. Belg., lviii. (1884) pp. 253–9.

found in the stomach, and which are probably the true excreta; and of much larger granulations formed of concentric layers, which seem to be true calculi, which are formed not in the intestine, but in tubes which open into it, and in which similar calculi are to be found. These tubes appear to be Malpighian; but the chemical examination of the calculi is still to be effected.

In conclusion, MacLeod throws great doubts on the exactness of the descriptions of the skeletal part of Acarina as given by previous writers, and promises to enter more fully into this subject.

δ. Crustacea.

Sexual Colour-Variation in Crustacea.*—Differences in the colour of the two sexes among Crustacea are of very rare occurrence. Darwin in 'The Descent of Man,' chap. ix., says he is acquainted with but two instances of this peculiarity: one in the case of *Squilla stylifera*, and a second in a species of *Gelasmus*, or fiddler crab. H. W. Conn records a third and very striking instance in *Callinectes* (*Neptunus*) *hastata*, the common edible crab of the southern coast of North America. There are a number of differences in the shape of the two sexes, but besides these they present a marked difference in colour. This colour-variation is confined to the first pair of thoracic appendages, the pair bearing the large chelæ. These appendages are of a yellowish brown on the upper surface, a whitish yellow on the outside, and of a brilliant blue on the inside and particularly at those parts which are protected from the light when the appendage is folded. It would seem therefore that this blue coloration was enhanced by not being exposed to light. The colour of different individuals is tolerably constant and uniform.

Between the colours of the male and female appendage considerable differences are discernible. The most noticeable difference is that the male appendage appears remarkably blue when compared with the female. This is due partly to the fact that the amount of blue surface in the male is much greater than in the female, and partly to the fact that the blue colour is of a much more brilliant hue. The blue colour in the male extends nearly to the tips of the two fingers of the chelæ, both the finger-like process of the propodite and the dactylopodite being largely coloured blue. The extreme tips are, however, of a brilliant purple. In the female these parts are of an orange hue, with not a trace of blue about them. Its tips are also coloured purple, but not so brilliant a purple as is found in the male. In the male the blue colour extends partly upon the outer surface. In the female it is confined to the inner surface and only extends to the base of the dactylopodite. The outer surface of the dactylopodite and of the finger-like process of the propodite are in the male white, while in the female they are reddish orange. Upon the male appendage there is no orange colour as a rule.

These differences in colour are in all cases very marked, and will always serve to distinguish a male from a female appendage. No

* Johns-Hopkins University Circulars, iii. (1883) p. 5.

colour differences are seen in any part of the crab except upon the first pair of appendages, and it is interesting to note that this sexual difference does not make its appearance till the crab reaches maturity. The chelæ of immature males and females cannot be distinguished from each other. Fritz Müller says that the same is true of the *Gelasmus* species observed by him. On the other hand, considering the habits of Crustacea, these sexual differences can hardly be considered as the results of sexual selection.

Observations on Tanais œrstedi.*—H. Blanc takes *Tanais* as his text for a study of the characters of the heteropodous Asellidæ. Commencing with a general account of the body and its appendages, he states that the differences between the cephalothorax of the male and female are not so well marked in young examples, and are not at all apparent in embryos. In old specimens the chitinous integument is incrusted with calcareous salts, which have the form of small masses, crystalline in structure, which may be either needle-shaped or rounded. The concretions are altogether similar to those found by Hoek in the Caprellidæ, and the differences in their form are due to the presence or absence of a hypodermic nucleus. The tegumentary glands are represented by three pairs of large glands which are placed beneath the lateral integument of the first three free segments of the thorax, and by twelve pairs of glands, which are much smaller than the others and are placed in the lateral portions of all the thoracic and abdominal segments, and in the head. The former are racemose in structure and closely resemble the same organs in *Phronima*, *Hyperia*, and *Corophium*. Each element of the racemose glands is formed of a mass of protoplasm, which contains two very clear nuclear vesicles, each of which is nucleolated. Each vesicle is, therefore, formed of two cells. The secretion from these cells passes out by small unbranched canaliculi, to reach the exterior by a single canal. The large thoracic glands are best developed in females carrying embryos in their incubatory pouches, and in them the glandular elements have their protoplasm almost entirely converted into a secretion. The product secreted hardens in the water and so forms a tube into which the *Tanais* may retreat; when fresh, and to the naked eye, this secretion appears to be filamentous; but when examined under the Microscope, it is seen to be composed of small rod-shaped corpuscles similar to those contained in the glandular elements. The secretion is more colloid than mucilaginous, for it does not coagulate with alcohol or form an emulsion with olive-oil. The secretion of the smaller pyriform glands probably has the function of secreting a product which prevents the animal from drying completely when it happens to float on the surface of the water.

The supra-œsophageal mass is elongated in the male, and short, widened out laterally in the female. It is distinctly divided into a superior optic portion and an inferiorly placed part which is larger and forms the true cerebrum. The differences between the supra-œsophageal ganglia of the male and female are carefully pointed out.

* Recueil Zool. Suisse, i. (1884) pp. 189–258 (3 pls.).

The arrangement of the nerve-cells in the ganglia of the ganglionic cord, as well as the double nature of the commissures which unite them, prove that the chain has arisen phylogenetically from two lateral nerve-cords. The whole nervous system of *Tanais* has a greater resemblance to that of the Isopoda than of the Amphipoda; the reasons for this statement are fully given.

After many vain inquiries the author was at last able to observe in a young specimen the presence in the auditory vesicle of very fine and very short hairs, which were arranged in a single row on a small part of its inner surface; no nerve could, however, be detected. Only twelve crystalline cones were found in the eye, and these were very short, and all of the same dimensions.

The muscles of the body and the appendages were arranged in the manner usual among the Isopoda. The fatty body completely surrounds both the dorsal and ventral faces of the intestine; below it also surrounds the ventral ganglionic chain and forms the so-called external neurilemma. In the abdomen, where it is most abundant, it forms two large masses on either side of the intestine. It seems to be more abundant in young than in old animals; in old specimens it disappears altogether, so that it seems to play an important part in the nutrient functions of the animal, and in the development of the body and its organs. The adult males take no food.

Respiration, in addition to being performed in the manner common among Decapods, is, as in Isopods, also abdominal. After a full description of the anatomy and physiology of the circulatory organs and of the digestive apparatus, in the course of which it is pointed out that the masticating stomach of the female is more complicated than that of the male, Blanc passes to the renal organs; the seat of the urinary secretion is the fatty body, and the products of secretion are deposited more or less largely along the intestine; they are yellowish in colour and have the form of agglomerated masses of small rounded or angular corpuscles. Chemical investigations have demonstrated the uric nature of their deposits, and observation has shown that they are more abundant in old than in young examples.

After some observations, not so complete as the author wished, on the sexual organs and on the "biology" of *Tanais*, Blanc discusses the question of whether they are Amphipods or Isopods; the balance of evidence seemed to him to be in favour of the latter, and to justify Milne-Edwards' establishment of a group of "Asellotes hétéropodes." As to whether *Tanais* is the ancestral form of the Isopods, as some have thought, it is necessary to be very careful, but, at the same time, one cannot fail to see such resemblances between *Tanais* and the zoëa-stage of Decapods as is represented by the mode of branchial respiration, the absence of abdominal appendages in the embryonic *Tanais*, and the possession of eyes placed on short stalks, and of an auditory vesicle which is open to the exterior.

New and Rare French Crustacea.*—In his 33rd article under this title M. Hesse deals with several new parasitic Crustacea

* Ann. Sci. Nat.—Zool., xv. (1883) art. No. 3, 48 pp. (3 pls.).

belonging to the order of the Siphonostomata, and especially to the Pelticephalidæ, of the genera *Nogagus*, *Lepimacrus* (nov. gen.), *Pandarus*, and *Cecrops;* all of these have been described and figured from living examples; they all live on fishes with an extremely thick skin, the scales of which are so closely arranged as to render penetration extremely difficult, and they all have a very special form of buccal apparatus, consisting of a rigid tube which is narrowed at its extremity, and which is deeply plunged into the flesh of the host so as to draw from it the fluids necessary for food. The fishes are all members of the group of the Squalidæ.

After a full description of *Nogagus spinacii* (*N. achantias*), we have an account of an attached embryo; the latter was 3 mm. long by 1 wide; it was provided anteriorly with an umbilical process which served as an organ of attachment, but was so flexible as to be able to be turned in various directions; on either side of this were a pair of long flattened antennæ formed of two joints, at the end of which were several divergent hairs. The eyes were relatively large and not widely separated from one another. The body was tubular in form and consisted of five rings, the first of which served as the point of attachment. These embryos were very active and lively, and on several occasions were seen to be living, even when the Crustacea to which they were attached were far gone in the way of decomposition.

The new genus *Lepimacrus* is founded on a single female specimen found on *Lamna cornubica*; the species is called *L. jourdanii.*

Several species of *Pandarus* and one of *Cecrops* are next described; and this is followed by some notes on their "physiology" and "biology." It is pointed out that the mucilaginous tegumentary secretions of the piscine hosts render the skin more supple and more easily penetrable by the organs which attempt to perforate them. When deprived of this advantage and incompletely fixed to a thick and coriaceous envelope they easily fall off when the fish is captured and withdrawn from the water, and are then difficult to find.* The parasites of the Squalidæ may be seen to select the thinnest parts of the skin, such as the axillæ or the eyes. *Scyllium canicula*, *catulus*, and *annulatus* have never been found to be infested with parasites, and it is a significant fact that their skin is very thick.

Hesse is of opinion that *Nogagus* should be placed with the Pandarinæ rather than the Caliginæ: and has some remarks on the term Siphonostomata, which has been rightly applied to those Crustacea, which, like the Pandarina, have a special syphonate buccal apparatus, by means of which they are able, after having pierced the skin of the fishes upon which they live, to penetrate their flesh and draw thence their nutriment; this apparatus is not, however, found in *Argulus*, or *Caligus*, which are ordinarily associated with them. (It may be observed that one of the best authorities on the Copepoda—Professor Claus—makes a special division—that of the Branchiura—for *Argulus.*) The forms just mentioned bite rather than prick. For the Argulina

* It may be pointed out, in this connection, that the number of parasitic Copepods collected by the 'Challenger' was very small.

and Caligina the author proposes the term of Rostrostomata—to which there is the obvious objection that it is a *vox hybrida*. The author gives a table to show the systematic changes which he proposes.

Vermes.

Nervous System of Euniceidæ.*—G. Pruvot finds in *Hyalinœcia tubicola* that the two central ganglia are so curved and connected by a thick median commissure that there is superiorly a "ventricle" which communicates by a large anterior cleft with the general cavity. In the family generally we find that the cerebroid mass is made up of two distinct parts, one cerebral and one stomatogastric; the antennæ and the organs of sense are innervated exclusively by the posterior or cerebroid portion of the mass; the unpaired posterior appendage represents a pair of appendages fused along the middle line. The stomatogastric centre alone provides the nerves of the palpi and the stomatogastric filaments, and the whole system presents essentially just the same arrangement as the general nervous system, for there is a supra-œsophageal centre, an œsophageal collar, and a ventral chain of, at least, two ganglia, the lower of which appears to the author to be constricted and to be formed by the fusion of what were primitively two ganglionic masses.

Cerebrum of Eunice harassii, and its relations to the Hypodermis.†—E. Jourdan describes the cerebral ganglia of *Eunice harassii* as being composed of a central mass of dotted substance, which is covered by a thick layer of nervous cells (the nuclear layer of Ehlers). Above this, and just below the cuticle, there are epithelial elements which are conical in form, and have their bases, instead of terminating on a membrane, prolonged into rigid filaments, which penetrate into the nuclear layer, and, by uniting, give rise to, as it were, pillars which pass from the cuticle to the mass of dotted substance. The protoplasm of these hypodermic cells is greatly reduced, and their nuclei are characteristically fusiform. They become lost in the nuclear layer, and closely fused with other fibrils, which have a similar histological character, but are of a different origin.

The nuclear layer, which is rightly regarded as being nervous in nature, is made up of various elements. In section the layer forms a delicate plexus between the hypodermic pillars, and each of the spaces is occupied by a spherical nucleus. The nerve-cells of the layer are composed of a large nucleus, hardly any protoplasm, and a fine enveloping membrane; they give off one or two processes, which are exceedingly delicate when taken singly.

The fibrils which are connected with them, but which, as has been already said, are of different origin, arise from the nerve-cells; though their function is no doubt different to that of the hypodermic fibrils their histology is absolutely the same. The spaces left in the

* Comptes Rendus, xcviii. (1884) pp. 1492–5.
† Ibid., pp. 1292–4.

reticulum are filled by a fine protoplasm, which is perhaps comparable to the granular substance of the neuroglia of Vertebrates.

The close relation between the hypodermic epithelial cells and their prolongations with their nerve cells and fibres, together with the absence of any histological differences between the two sets of fibrils, are especially interesting as calling to mind the characters of the nervous system of larval Annelids.

Varieties of Branchiobdella varians.*—W. Voigt has a careful study on the variations of *B. varians*.

He finds that we have here to do with an animal which may be of great importance in our knowledge of the mode of origin of species. He shows that it is on the very point of giving rise by its varieties to new species. The so-called *B. parasita* is undoubtedly the form from which the others have been derived. The fact that the variety *hexodonta* found on the gills of crayfishes in North Germany is replaced in South Germany by the variety *astaci* points to external influences as being the cause of this local distribution; the differences may be supposed to be due to temperature or to the qualities of the water, or the bodies dissolved therein. To such suppositions there are, however, powerful objections, and we must therefore look for the causes of variation in the animals themselves. Differences have been observed in the size of the ova, and in the characters of the dissepiments between the segments which carry the segmental products; with these other differences appear to be correlated, but their exact relations have as yet to be carefully worked out.

Ovum and its Fertilization (in Ascaris).†—The discrepancies in the recorded observations of fertilization in the ova of Echinoderms led E. van Beneden to study the subject in fresh types, and finally to pursue in the *Ascaris megalocephala* of the horse the important series of observations which he has recently published in great detail. The memoir is divided into four descriptive chapters and a general summary.

The first chapter describes the constitution of the ovum and spermatozoon.

The advantage to be obtained from studying the ovum in this Nematode is that in the uterus and oviduct definite stages of fertilization constantly occur at definite points.

On quitting the ovarian rachis the previously bilateral ovum acquires an elliptic form, and—at the point of previous attachment—shows a micropyle, underlying which is a naked protoplasmic process, the *plug of impregnation*, situated on a *polar disk* forming a slight eminence on the transverse (or short) axis of the ellipsoid. Ultimately a delicate membrane comes to cover the ovum except at the micropyle. Within the so-called "nucleus," or *germinal vesicle* (which is bounded by a membrane), is the "nucleolus," or *germinal corpuscle*, consisting of *two* disks and situated peripherally on the

* Arbeit. Zool. Inst. Würzburg, vii. (1884) pp. 41–94 (2 pls.).
† Arch. de Biol., iv. (1883) pp. 265–610 (1 pl.).

prothyalosome, a differentiated, and slightly elevated, portion of the nuclear mass.

Within the uterus of the fertilized female the zoosperms occur in four forms, marking four stages of development, though all are capable of fertilization. Except in the first, or simply amœboid, stage, each zoosperm consists of a granular, nucleated, *cephalic hemisphere*, and of a caudal process containing a refringent body and fibrils of a contractile nature. A definite membrane surrounds the "tail" of the zoosperm, ending with a free border at the neck, and not investing the naked protoplasm of the cephalic hemisphere.

The second chapter deals with the penetration of the zoosperm into the ovum, i. e. with "the copulation of the sexual products." On this subject Van Beneden has observed that, in Nematodes, as a general rule, only one zoosperm penetrates an ovum. The erroneous view that many zoosperms entered to fertilize a single ovum, is due to the presence of certain refringent bodies in the vitellus. (In Mammals, where many zoosperms commonly penetrate an ovum, one only effects fertilization, the others being assimilated as food.) The zoosperm always enters at the micropyle, round which the membrane of the ovum rises up to form a "perivitelline space." On entering, the zoosperm applies itself to the "plug of impregnation" by its cephalic hemisphere,—its axis being thus applied in continuation of the embryonic axis of the ovum, and the homologous regions of the two elements being thus brought into contact.

Aided by its own amœboid movements, the zoosperm is now borne into the ovum centripetally by the protoplasmic process to which it is applied. The membrane of the zoosperm enters into intimate relations with the egg-membrane, finally fusing with it to form a continuous *ovo-spermatic membrane*.

In his third chapter, Van Beneden deals with the "modifications which take place in the ovum from the time of copulation of the sexual products to the time when the unification of the mature ovum and zoosperm commences."

In *Ascaris megalocephala* a *Upsiliform figure* represents the first "directive spindle" of Bütschli (Fol's first "amphiaster de rebut"). This characteristic figure consists mainly of achromatic fibrils, with two chromatic disks, lying in a clear body (representing the prothyalosome) at the junction of the three limbs of the Upsilon. The chromatic elements are derived from the germinal corpuscle, the achromatic fibrils from the germinal vesicle and its membrane.

As the zoosperm reaches the centre of the ovum, the vertical limb of the Upsilon becomes connected with it by filaments (probably muscular in function), and the figure becomes T-shaped, the transverse limb taking on the appearance of a spindle. Meantime the vitellus loses all traces of its radiate structure, becoming granular throughout.

"The first *polar body* is now formed at the expense of the reduced prothyalosome and of the chromatic elements it contains. Each of the two chromatic disks furnishes to the polar body the half of its substance, and the prothyalosome divides tangentially. The elimination

is not of a pole of the spindle, but takes place in the equatorial plane."

In the vitellus a homogeneous *perivitelline layer* is differentiated peripherally, and the refringent body in the caudal portion of the zoosperm is ejected into the perivitelline space. In spite of the striking analogies, the genesis of the first polar body is not to be compared to indirect cell-division.

After the elimination of the first polar body there remains an homologous body, the *deuthyalosome*. This latter body increases in size at the expense of the vitellus and developes two "asters" on its surface, one peripheral, the other central. Complicated *pseudo-karyokinetic figures* are now formed, but disappear before the elimination of the *second polar body*, which is formed from the deuthyalosome much in the same way as the first polar body from the prothyalosome, and apparently at the same spot on the ovum. A second perivitelline layer is now formed. The second polar body (i.) is the equivalent of the female pronucleus which remains behind, and (ii.) cannot be regarded as a cell.

So far, Van Beneden concludes, no phenomena of true fertilization have occurred, merely "phenomena of the maturation of the ovum."

The formation of the pronuclei and the true phenomena of fertilization are treated in the fourth chapter. The female pronucleus (the equivalent of the second polar body) consists of chromatic and achromatic elements, derived from the germinal corpuscle and the prothyalosome respectively. Contemporaneously with the expulsion of the second polar body, the male pronucleus is formed, exclusively from the *nucleus* of the zoosperm. Ultimately the two similar pronuclei meet in the centre of the reduced ovum (or *female gonocyte*, as it is now termed), and unite partially *without fusion*. A single dicentric karyokinetic figure is now formed (derived equally from the two pronuclei), and segmentation begins.

"The egg, furnished with its two pronuclei, behaves like a single cell, and the sum of the *two* nuclear elements is equivalent to a simple nucleus. The first cell of the embryo is accordingly formed from the moment when the two pronuclei are fully developed; fertilization coincides with the genesis of the two pronuclei."

Van Beneden concludes that "fertilization consists essentially in the formation of the female gonocyte, and its transformation into a cell, that is to say, in the replacement of the expelled elements by the new elements introduced by the zoosperm. The polar bodies are replaced by the male pronucleus."

All cells of the tissues are thus hermaphrodite, and fertilization is not a generation but merely a substitution requisite for the indefinite conservation of life.

Spermatogenesis in Ascaris megalocephala.*—We have yet another contribution to our knowledge of the development of spermatozoa, from E. van Beneden and C. Julin. The Nematodes in general and *Ascaris megalocephala* in particular lend themselves remark-

* Bull. Acad. R. Sci. Belg., vii. (1884) pp. 312–42.

ably to a study of the successive phases in the development of the spermatozoa, not only on account of the comparatively large size of the spermatozoa, but also because of the simple and typical arrangement of the male apparatus, which is formed by a single tube whose diameter insensibly increases in size from the blind end to the orifice. The best method of investigation is to use the double means of first examining successively dissected portions of the seminal tube, and of making a series of sections of a tube first hardened and properly stained. If we wish to avoid the errors into which preceding writers have fallen, we must be very careful to neglect no part of the tube. The later authors, such as Schneider, Nussbaum, and Hallez have, further, committed the fault of neglecting the bibliography of the question, and especially the excellent work of Munk published as long ago as 1858.

The authors proceed to a description of the several parts of the male tube—testicle, efferent canal, seminal vesicle, and ejaculatory canal. They describe then in detail and sum up their results in the following terms:

It is necessary, in the history of spermatogenesis, to carefully distinguish between the formation of the spermatogonia at the expense of the spermatomeres, and the division of spermatogonia into spermatocytes. The multiplication of spermatogonia appears to be effected, in *A. megalocephala*, directly and not by karyokinesis, while the spermatocytes arise by the indirect or karyokinetic division of the spermatogonia. The karyokinesis presents some special characters; the typical form of the chromatic cord is replaced by a rod-shaped form, and the primary loops have the shape of truncated cones. The longitudinal division of the primary loops results from the appearance of a circular vacuole in each of the pyramids; this vacuole extends to the equatorial plane, and brings about the division of the pyramid into two quadrilateral plates, which represent the secondary loops. The polar corpuscles which occupy the centre of the attractive spheres are remarkable for their affinity for colouring matter. The asters may be distinctly seen to be the cause of the temporary division of the cell into three portions, separated by circular constrictions.

In the region where the spermatogonia are formed at the expense of the spermatomeres there are to be observed, between the cells, corpuscles which have a close resemblance to polar globules; these the authors call residual globules. They appear to have been expelled by the spermatomeres after the karyokinetic metamorphosis, and the expulsion seems to be effected in the equatorial plane of the dicentric figure, as in the case of the polar globules. If this account be correct, the residual corpuscles are comparable to the polar globules of the egg.

The spermatocyte, before becoming a spermatozoon, gives off a portion of its substance, which belongs to the cytophoral part; the formation of the cytophore is in no way comparable to a cell-division. Just as the egg, when completely matured, is a cell reduced to that which Van Beneden has called a female gonocyte, so is the spermatozoon

a reduced cell. The reduction is accomplished in two distinct stages of development; first affecting the spermatomeres, and then the spermatogems. While each spermatocyte intervenes in the formation of a cytophor, the residual corpuscles are formed by the spermatomeres, in such a way that not only each spermatocyte (and, therefore, each spermatozoon), but also each spermatogon only possesses a reduced nucleus.

Spermatogenesis in Ascaris megalocephala.*—P. Hallez, like E. van Beneden, has selected this convenient Nematode for the study of the phenomena of spermatogenesis. After a short description of the male organs, he points out that young of different ages as well as mature specimens must be examined. The spermatospores, which are formed at the blind end of the seminal tube, consist of a homogeneous extremely transparent protoplasm; by division into four the nucleus gives rise to four protospermatoblasts, which form protospermatogems. The former give rise to a (second) generation of deutospermatogems, which are formed by a large number of deutospermatoblasts. The last become isolated, and consist of a homogeneous protoplasm and a nucleus which is deeply stained by reagents. As they increase in size their protoplasm becomes finely, then more distinctly granular, while the nucleus grows larger and developes a nucleolus.

When they have reached a size of about 18 μ in diameter they divide by nuclear division; and this division is effected at about 440 mm. from the blind end of the seminal tube.

The deutospermatoblasts now become filled with refractive granules, and soon exhibit a phenomenon which has not yet been observed in the animal kingdom. They undergo conjugation by pairs, and the two become closely united with one another. The nuclei, after fusion, separate afresh. As they tend to separate from one another each gives rise to corpuscles, which resemble polar globules.

The further development of the separated and ejaculated deutospermatoblasts must be made out in the organs of the female; when they first enter the ducts they are spherical cells, 18 or 19 μ in diameter, their protoplasm is filled with refractive granules, and they have a nucleus which can be easily stained. After a certain time the refractive or nutrient granules disappear, and the deutospermatoblasts appear almost to be amœboid in character. They are now converted into spermatozoa, which are ordinarily conical or pyramidal in form; the nucleus is constantly found outside the spermatozoon. The fertilizing element is now ripe and may be seen to apply itself to and fecundate an ovum.

Nematoids of Sheep's Lungs.†—F. Karsch has a notice of A. Koch's essay on the Nematodes of sheep's lungs, in which especial attention has been given to *Strongylus rufescens* and its developmental history. The author found in the lungs of a Hungarian race of sheep a number of hair-like microscopic parasites which he regarded as new

* Bull. Sci. Dép. Nord, vi. (1883) pp. 132-5.
† Biol. Centralbl., iv. (1884) pp. 51-3.

and to which he applied the name of *Pseudalius ovis-pulmonalis*. The males are brown, the females milky white in colour; the latter lays its eggs in the finest branches of the bronchi, and the pulmonary alveoli; the young escape by the trachea, and the sexually mature forms enter by the same passage. The young make their way into mud or water, and thence pass first of all into the stomach of the sheep; to return again to the gullet and so to get into the larynx. The author believes that he has here to do with a diminutive form of *S. rufescens*, which, by constantly living in the finest terminations of the bronchi, has accommodated itself to the diminishing calibre of these vessels.

Free-living Nematodes.*—Up to the present the free-living Nematodes have received comparatively little attention; absolutely nothing is known about the exotic forms, and but few notices have been published of the forms that occur in Europe. In England Dr. Bastian has published an elaborate memoir of the free-swimming Nematodes, chiefly the marine forms; while on the Continent Eberth, Schneider, Marion, and Bütschli have contributed largely to our knowledge of the group. The Monograph of De Man deals exclusively with those species that are found in the Netherlands. The work is divided into two parts, a general and a systematic; in the first is treated the history of the group, their organization, mode of life, capture, methods of preparation, and their geographical and seasonal distribution in the Netherlands. The second half contains a description of all the species found in the Netherlands, as well as a notice of all the free-living species that have been described, with references to the published descriptions. The text concludes with two tables showing the distribution in the Netherlands of the different species, and a classification of the species according to the size of the body. The Monograph is illustrated by thirty-four plates.

Trichina and Trichinosis.†—This work is the result of a duty intrusted to J. Chatin by the French Government, who desired exact information as to the character of the preserved meats imported from America. The author concludes that "in the name of public hygiene, as well as in that of agricultural interests, public opinion demands a careful examination of all animals that enter the country, whether they be alive or dead." But he points out that it is for the legislator to prescribe the measures which are necessary for preserving the public health, and that the business of the naturalist is concluded when he has investigated the history and development of the parasite, and has drawn from these conclusions as to prophylactic methods. The work is one which should be known to all who are engaged in either the physical or legislative problems which surround the question of diseased meats.

* 'Die frei in der reinen Erde und im süssen Wasser lebenden Nematoden der niederländischen Fauna.' Leiden, 1884. 34 pls. Cf. Biol. Centralbl., iv. (1884) pp. 191–2.

† 'La Trichine et la Trichinose.' Paris, 1883, 8vo, 257 pp. (15 pls.).

Cystic Stages of Tæniadæ.*—A. Villot finds, as a result of prolonged inquiries into the characters of the cystic stages of Tapeworms that the mode of formation of the head is identical in all species, genera, and types. The true head, the future scolex, never proceeds directly from the caudal vesicle; it is always separated from it by an intermediate portion, which he has called the body, and which forms its immediate envelope. The differential characters which can be drawn from the modifications in structure and development have only a secondary value and cannot be used as the basis of a natural classification. In the next place, it is to be observed that, contrary to what is ordinarily taught, the caudal vesicle of the cysticerci may be formed in different ways; these differences have a future morphological importance. Cysticerci are either cysticerci properly so called, or are cysticercoids; the latter may be grouped under two heads and subdivided into six entirely new genera. The first section consists of those in which the caudal vesicle is formed by endogenous gemmation, and here we have *Polycercus* for the form found by Metschnikoff in *Lumbricus terrestris*, *Monocercus* for the so-called *Cysticercus arionis*; in the second section, or that of those in which the caudal vesicle is formed by exogenous budding, we have *Cercocystis* for the form found in the larva of *Tenebrio molitor*, *Staphylocystis* for *S. bilarius* and *S. micracanthus*, *Urocystis* for a form found in *Glomeris*, and *Cryptocystis* for the curious form found by Metschnikoff in the visceral cavity of *Trichodectes canis*.

The forms that are the most ancient and most closely approximated to the primitive type appear to be those that belong to the genera *Urocystis* and *Cryptocystis*; it is in these that we observe the greatest independence between the different stages of development; the proscolex, cystic, and scolex-stages are perfectly distinct; the first, after having budded off the caudal vesicle separates from it, so soon as it has attained maturity, and no part of the proscolex is found in the perfect cysticercus. In *Staphylocystis* and *Cercocystis* the caudal vesicle adheres to the blastogen, but has only the function of a support or simple appendage. In the first section of the cysticercoids the blastogen not only persists, but forms a permanent envelope. In passing from the cysticercoids to the true cysticerci we advance another stage in the scale of differentiation, and, at the same time, note a remarkable abbreviation in the history of development, for the stage represented by the budding of the caudal vesicle is entirely suppressed. This "serial co-ordination" of the cystic stages may be expressed by the simple law that the most differentiated types of organization have their development the most condensed; those that are relatively lower are more diffused; in other words, the complication of development and of organization are in inverse relation to one another.

Anatomy and Development of Trematoda.†—J. Biehringer devotes the greater part of this essay to sporocyst-stages, and has investigated the characters of *Cercaria armata*, *C. macrocerca*, *C. micrura*,

* Ann. Sci. Nat.—Zool., xv. (1883) art. No. 4, 61 pp. (1 pl.).
† Arbeit. Zool. Inst. Würzburg, vii. (1884) pp. 1–28 (1 pl.).

Bucephalus polymorphus, *Cercaria acerca* n. sp. (found in various organs of *Onchidium carpenteri*), and another sporocyst from a species of *Onchidium* from Singapore.

In describing the structure of the sporocysts, he deals with the epidermis, and points out that the so-called cuticle is not truly a cuticle, but is a membrane in which a varying number of nuclei are to be detected; its development is difficult to follow, but it would seem to be due to the fusion by peripheral growth of some of the outer cells of the gastrula, and to be comparable, therefore, to the ectoblast of the first order, which has been described by Schauinsland in the embryos of Trematodes, and to the embryonic investment of *Tæniæ*, as described by E. van Beneden. On the whole, we are justified in regarding it as an epidermis and comparing it with the "hypodermis" of other worms.

The muscular layer is always very thin, and its outer layer consists of delicate, closely applied, circular fibres; below these is a longitudinal layer, which is often much less distinct. *Cercaria macrocerca* is remarkable for having them broader and more distinct from one another than they are in other forms.

The germinal epithelium is in most cases unilaminate, and varies in form in different species, the cells being cylindrical, cubical, or flattened. *C. macrocerca* is here again remarkable for having large clear cells, which may be set in one or several layers. On their distal side there are nuclei, which lie in a protoplasmic fundamental substance, and which in section appears to form an anastomosing plexus.

The so-called paletot is a fourth layer which is often present, and which, in the opinion of Leuckart, is due not to the guest but to the host; and the author is of opinion that the substratum from which it arises is the blood of the host, while the elements of which it is composed are the cells of the snail's blood. After discussing this question at some length Biehringer passes on to the sucker or depression which is often found at one pole of a sporocyst; its structure agrees so completely with that of the rest of the body-wall that it may be considered as a mere invagination of the whole sac. It no doubt serves as an organ of attachment.

In dealing with the formation of the germinal bodies, and beginning by discussing the views of previous writers, and especially of Leuckart and A. P. Thomas, with the latter of whom he is in complete agreement, he tells us that he is led by his own observations to think that the developmental cycle of the Trematoda is a real case of alternation of generation.

In conclusion there are some remarks on the influence which the gradually developing brood exercises on the organization and activity of the sporocysts. When the brood remains at a lower grade of development the nurse contrives to grow; later on, when the daughter generation is undergoing further development, it suffers a passive extension, but this does not equally affect the whole of the body of the nurse, but depends on the number and size of the germinal bodies which are to be found in any given zone of its body. At last, the whole mass forms a mere sac without any sign of organization, for the brood at last completely destroys the body of the mother.

Worm-fauna of Madeira.*—P. Langerhans has published the fourth of his contributions on the worm-fauna of Madeira, in the course of which he describes various new species and one new genus. Among other points of interest the author has some suggestions as to the divisions of the Serpulidæ, our knowledge of which is in a most unsatisfactory condition. In that family he recognizes three types; the first of these is *Serpula* itself, in which the thoracic segments bear only one kind of dorsal seta; here belong *Serpula*, *Eupomatus*, *Pomatocerus*, and *Placostegus*. *Filograna* is the second type, and in it all the thoracic segments behind the second have, in addition to the Serpulid setæ, those of the kind first detected by Claparède in *Salmacina*. Here we have *Spirorbis* and others. The third type is represented by *Vermilia infundibulum*, in which a fresh type of seta, in addition to those already noted, is present.

Of the twenty species of Nemerteans found by Langerhans, seventeen are known to be members of the European seas.

New Species of Rotifer.†—Sara G. Foulke describes a new species of rotifer under the name *Apsilus bipera*. In common with all members of the genus, they possess, instead of rotatory organs, a membranous cup or net, which is used for the capture of food. The specific distinction of the new form consists chiefly in the structure of the net, the presence of a true stomach in addition to the usual crop, and the presence of cilia inside the net. It is proposed to unite the forms *Apsilus lentiformis* Mecznichoff, *Dictyophora vorax* Leidy, and *Cupelopagus bucinedax*, Forbes, and the new species in one genus, *Apsilus* (Fam. Apsilidæ), in consequence of their strong points of resemblance. These are, briefly, the presence of two eye-spots, of a membranous cup, of a mastax exactly similar in all, of the absence of tail or foot-stalk, of the absence of carapace, and of the similar habits.

Prof. Leidy subsequently declared all four forms to form the same species, with which opinion Miss Foulke does not agree.

Echinodermata.

Development of the Germinal Layers of Echinoderms.‡—E. Selenka finds that egg-cleavage in Echinoderms is regular, but that of Ophiurids and Asterids is really "pseudoregular," and that of Echinids regular with polar differentiation; we cannot as yet exactly define what we mean by a regular cleavage, and its various modifications are as yet insufficiently known; we may, however, distinguish under its head those eggs into which the first two blastomeres are of the same size, and those in which cleavage is on the whole regular, with the exception of the first plane of cleavage. The various modes of cleavage exhibited by the eggs of Echinoderms are of no value for the phylogenetic history of the group; the influence of cenogeny is

* Zeitschr. f. Wiss. Zool., xl. (1884) pp. 247–85 (3 pls.).

† Proc. Acad. Nat. Sci. Philad., 1884, pp. 37–41 (1 pl.).

‡ 'Studien über Entwickelungsgeschichte,' ii., Wiesbaden, 1883, pp. 28–61 (6 pls.).

apparent enough. The blastula is of the same thickness throughout; in Echinids, and probably also in Asterids and Ophiurids the blastodermic cells are broader on the lower surface, in the Holothuroidea they are of the same size all round. The mesoblast arises from the primitive cells of the mesenchym and from the diverticula of the archenteron. The former, by means of their daughter-cells, and in the form of wandering cells, make their way into the blastocœlom and give rise to the circular musculature of the fore-gut and to the cutis. The archenteric diverticula and their derivates consist first of a single layer of cells, from which later on scattered cells arise peripherally and form an outer ring of unicellular muscles. The explanation of this double mode of origin is not easy; it may be said that the two primitive cells of the mesenchym are the homologues of the two primitive cells of the mesoblast of molluscs, Arthropods, &c., and that the archenteric diverticula are new formations ("neomorphs"); while there are several good reasons to be given in support of this hypothesis there are others that favour the view that the diverticula form the primitive seat of origin of the mesoblast and that the mesenchymatous cells are cenogenetic. Lastly, and this is perhaps the best view of all, the mesenchym-cells are portions of the archenteric diverticula, which in consequence of the modification of the larval life, have precociously separated from the rest.

The "blood-corpuscles" of the water-vessels are found to arise from epithelial cells of the rudiments of the water-vessels, and those of the enterocœlom from the peritoneal or cœlomic epithelium.

Evidence of the vermian origin of Echinoderms is afforded by the primary mesoderm having the form of two primitive cells, and by the bilateral symmetry of the larval organs. The division of the archenteric diverticulum into cœlomic sac and water-vessels corresponds physiologically to that which the mesodermic sac undergoes in Vertebrates, and to some extent in worms.

New Genus of Echinoids.*—Prof. F. Jeffrey Bell institutes a new genus for the *Echinanthus tumidus* described a few years since by Mr. Tenison-Woods, on the ground that the rows of ambulacral pores, instead of being approximated at their free end, tend to widen out in a lyre-shaped fashion; and the genus is thereby removed "from the direct line of ancestry through which the *orthostichous* passed to the *petalostichous* Echinids." He alludes to the significance of this form being found in the Australian seas, and expresses a belief that further research will result in the discovery of other forms which have been unsuccessful in the struggle for existence.

Revision of the Genus Oreaster.†—Prof. F. Jeffrey Bell revises the twenty-seven known species of *Oreaster* and describes five new species; in the systematic disposal of the species he has attempted to gain some assistance from the study of their post-larval development, especially as regards the number and arrangement of their spines; he

* Proc. Zool. Soc. Lond., 1884, pp. 40–4 (2 pls.).
† Tom. cit., pp. 57–87.

believes that "in the investigation of the spinulation of star-fishes there is a wide field for the study of those mechanical causes with which the zoologist is concerned."

Organization of Adult Comatulidæ.*—E. Perrier finds in *Antedon rosaceus* and *A. phalangium* that the "axial organ" is a tubular cavity with glandular walls; of its diverticula some appear in section to be cæcal, while others are continued into canals, most of which pass towards the dorsal integument and form around the œsophagus the spongy organ of H. Carpenter. The canals (the author cannot call them vessels) take a sinuous course, anastomose frequently, and have walls which are clearly glandular; they open by ciliated infundibula. The author regards all these as parts of one and the same system, and as comparable to the madreporic plate, sand-canal, and ovoid gland of Echinids, Asterids, and Ophiurids. Perrier finds in the characters of young larvæ—such as the disposition and mode of formation of the single canal—facts which lead him to think that the organization of the Comatulid is closely allied to that of other Echinoderms. Reserving details he here points out that if we consider an urchin as a Crinoid whose arms have become firmly united with the disk (as is the case, for example, in *Eucalyptocrinus*), and whose mouth was situated at the point of insertion of the disk to the stalk, the nervous system and the ambulacral canals of the urchin would have exactly the same relations as those which are presented by the Comatulid. He further remarks that the calyx of numerous Crinoids becomes invaginated and presents points which are not without analogy to the lantern of Aristotle in certain (and especially in Clypeastrid) Echinids.

Cœlenterata.

Anatomy of Campanulariidæ.†—It is generally believed that the "theca" and the chitinous layer which covers the stem in the Hydroida is a secretion from the ectoderm layer of the polyp. This however does not seem to be the case with the Campanulariæ. H. Klaatch has been furnished by a detailed study of *Clytia johnstoni* with evidence tending to show that the chitinous sheath of the Campanulariæ is a product of differentiation of the ectoderm, an epidermoid formation, the equivalent of a tissue. If this were not so, and if the chitinous layer were a mere secretion from the ectoderm, as it is in *Cordylophora lacustris* according to the researches of F. E. Schultze, we should expect to find the whole of the body of the polyp covered by a continuous layer of ectoderm entirely similar everywhere, and the growth of the chitinous covering to be increased by the deposition of fresh layers of horny substance; on the contrary, it appears that the outer epithelium which covers the tentacles, the head, and the "body" of the polyp is not continuous with that of the stem, but at the posterior end of the stomach bends back and becomes continuous with the calyx itself, actually passing into it, the

* Comptes Rendus, xcviii. (1884) pp. 1448–50.
† Morph. Jahrb., ix. (1884) pp. 531–96 (3 pls.).

process of the modification of the cells into horny matter having been clearly recognized; "in the stem no outer epithelium can be expected; its absence is a proof that the chitinous sheath is a product of the differentiation of the ectoderm."

The chitinous theca therefore of *Clytia* is not homologous with that of *Cordylophora*. Beneath this "epidermis layer" of *Clytia* follows a deeper ectoderm layer, corresponding to the neuro-muscular layer of *Hydra*, &c., which differs in the "body" and stem of the polyp; in the former there is a thick homogeneous layer to which the term middle zone ("*mittelzone*") is applied; this in the stem and the disk of the polyp becomes a distinctly cellular layer, one passing into the other without any break; the outer cellular layer of the stem is not therefore, as might appear from a casual inspection of Klaatch's figure, the equivalent of the outer ectoderm layer—the "epidermis-schicht," but really represents the "mittelzone," and has nothing to do with the formation of the outer chitinous layer which is formed by a metamorphosis of the "epidermis-schicht."

The different conditions of the middle zone may be perhaps explained by its different functions in the body and stem of the polyp respectively; in the body it undergoes alterations of diameter in various stages of contraction, and from this fact appears to be rather muscular than nervous in nature; in the stem, on the other hand, the rigidity of the chitinous investment would seem to render the presence of a muscular layer unnecessary, and it is very possible that the cells which in this region of the polyp represent the "muscular" layer of the body are modified to form nervous structures which receive impressions and control the movements of the muscular layer of the body, with which, as has been already stated, they are in direct connection.

Structure of the Velellidæ.*—**M.** Bedot finds that in young Velellidæ the two layers of which the crest of the pneumatocyst is formed are not united together; they first appear as a fold of the upper part of the pneumatocyst. The "liver" is of some complexity; on its upper or convex part there is a single layer of cells which is in direct contact with the pneumatocyst; below this is a lamella, in which no cellular structure could be made out; against this there are applied the canals of the "liver," which form a kind of roof for a large mass of cnidoblasts; the presence of these last demonstrates that the so-called liver does not perform hepatic functions. Below it there are again some canals which differ from the more superior by being unpigmented; they are attached to a similarly structureless lamella. The two sets of canals are connected with one another through the substance of the organ.

The complicated vascular system arises simply as two straight canals which open into the marginal one; they bifurcate at a short distance from their point of insertion. In the course of their development they become sinuous and give rise to a number of ramifying cæca, which anastomose with those of the adjacent canals.

* Arch. Sci. Phys. et Nat., xi. (1884) pp. 328–30.

Actiniæ of the Bay of Naples.*—A. Andres publishes the first half of his monograph, in which he limits himself to the bibliography and systematic descriptions of the species; this is very fully done, and the plates are of exquisite beauty.

Protozoa.

Morphology and Anatomy of Ciliated Infusoria.†—E. Maupas commences an important essay with a brief review of the more valuable works that have already appeared; after which he enters on a description of *Colpoda cucullus*, the food of which is stated to consist of bacteria, vibrios, micrococci, and small monads. *Colpoda steinii* is next dealt with, in which four forms are distinguished. These two species are very widely distributed.

A new genus *Cryptochilum* is instituted for the *Cyclidium nigricans* of O. F. Müller, which, though closely allied to *Paramecium*, *Colpoda*, *Colpidium*, and *Cyclidium*, may, the author thinks, be justly distinguished from any one of them. A new species of this genus is *C. elegans*, which is much larger than *C. nigricans*; it was discovered near Algiers. *Paramecium griseolum* of Perty is removed to this genus; and *C. tortum*, found near Algiers, and *C. echini*, which was found living parasitically in the intestine of *Echinus lividus*, are described as new species.

Some parts of the structure of *Colpidium colpoda* are fully entered upon; *Glaucoma pyriformis* (*e*) is described in detail, and the structure of the mouth of *G. scintillans* is discussed. *Ophryoglena magna* is a new Algerian species which is fully described and compared with its allies.

A new genus *Ancistrum* is instituted for the *Opalina mytili* of Quennerstedt, and for *A. veneris gallinæ*, a new species found in *Venus gallina* at Algiers. They lead the life of commensals, and the genus is allied to *Pleuronema* and *Ptychostomum*. Quennerstedt failed to notice the mouth, which is, however, really present.

Nassula oblonga (found in the sea off Roscoff), *Chilodon dubius* which might almost be made the type of a new genus, *Holophrya oblonga* (sea off Algiers), and *Lagynus crassicollis*, from a similar locality, are all new species. *Loxophyllum duplostriatum* (new species) is remarkable for the characters of its striation, which at once distinguishes it from all its allies. Interspersed with and following these descriptions are notes on some other species, after which the author enters upon a discussion of the organology of the Oxytrichida. Before defining his terminology he very justly urges that a good comparative morphology can only be established by the aid of a very exact terminology, based on as complete a comparison as possible. In the case of the Infusoria this may seem to be impossible, but it is because it has not been vigorously aimed at that such differences obtain in the comparative studies of even the best naturalists. To cite some of the terms em-

* 'Fauna und Flora des Golfes von Neapel. ix. Die Actinien.' 1884, 459 pp. (13 pls.).

† Arch. Zool. Expér. et Gén., i. (1883) pp. 427–664 (6 pls.).

ployed: the ventral surface always carries the mouth and the various appendages which function in locomotion and in the production of the nutrient currents; the prebuccal and postbuccal regions vary greatly in their proportional extent, and it would seem that the suppleness and contractility of the body stand in an inverse relation to the development of the prebuccal region; this may be distinguished into a peristome and a lateral area; and they, also, differ in the proportional extent to which they are developed. Four kinds of appendages may be distinguished: vibratile cilia; cirri, which are stylet-shaped, and much larger at their base than at their free-end, and which may be abdominal, transverse, or marginal; setæ, which are filiform, homogeneous, and simple, but rigid like needles, and which may be dorsal or caudal; the latter are much longer and stronger; lastly, the vibratile membranes are either those properly so called, or are buccal "membranelles."

Actinotrocha saltans, *Gonostomum pediculiforme*, *Holosticha lacazei* n. sp. (seas near Algiers), *H. multinucleata* n. sp. (port of Algiers), *Uroleptus roscovianus* n. sp. are then described.

The author proposes to replace the terms Protozoa and Metazoa by those of Cytozoa and Histozoa.

Attention is directed to the characters of the naked Infusoria, which are not all members of the group Acinetæ, but are found also among the Ciliata. The existence of forms without an integumentary layer shows that its presence or absence is in no way associated with the grade of development to which a Cytozoon may arrive, but that the protoplasm is ready to take on the most varied forms and structure, without the addition of an external protecting layer. The views of Häckel as to the typical constitution of the integument of an Infusorian are discussed, and the conclusion is come to that the "cuticular layer" is perfectly distinct from the skeletal cuticular formation, that the ciliary and myophanous layers have no existence, and that the layer of trichocysts is a part of the sarcode and not of the integument. Contrary to the views of Häckel, with regard to whom Maupas expresses himself in the most energetic manner, the integument of ciliated Infusoria is looked upon as corresponding morphologically to the membrane of the cell, of which it has all the physical properties. The integument is, in fact, defined as any distinct superficial layer, which is intimately applied to the surface of the cell, and lives the same life as it does. The various conditions under which it presents itself are then described.

The physiological properties of the sarcode or cytosome strike one by their resemblance to those of the body of the Rhizopoda, and lead one to think that an Infusorian may be defined very exactly as a Rhizopod inclosed in an integument and provided with appendages which are destined to fulfil the external functions which the sarcode of the Rhizopod performs for itself.

The author's observations on the trichocysts are stated by him to confirm those of Allman. The doubly refractive bodies which have been ordinarily regarded by those who have studied them as urinary concretions, offer us an important specific character, as they may be

present in one species and absent from another which closely resembles it. The fibrillated appearance of some of the appendages is regarded as being due to the coalescence of separate cilia. When the integument is highly differentiated and very distinct from the underlying sarcode, the orifice of the contractile vacuole is represented by a permanent and constantly visible pore. The author concludes with some observations on the nucleus and nucleolus, in which he insists on the fact that the latter is certainly absent from some forms, even in those that are multinucleated, and he points out the difficulty which this absence presents to our accepting the views of Balbiani as to the mode of conjugation of the Ciliata.

Trichomonas vaginalis.* — J. Künstler has now published the full text of his article on this flagellate, a preliminary notice of which was given *ante*, p. 67.

Acanthometra hemicompressa.†—Dr. L. Car gives an account of this new Radiolarian which is characterized as follows:—The spicules are long and thin, pointed at the extremity; the basal portion is quadrangular, the distal half is circular in transverse section, the proximal half lenticular, the two halves are of equal breadth, and this distinguishes the species from *A. compressa;* the spicules are elastic, but the elasticity is not so well marked as in *A. elastica;* the basal portion which is inserted into the central capsule is quadrangular and provided with triangular wing-like processes; it terminates in a fine point; although these spicules are so elastic they appeared usually to be broken. The central capsule is transparent, and the distal portion only of the spicules projects outside; as in other Radiolarians the central capsule contains a number of colourless and yellow cells. In its general characters this species is intermediate between *A. elastica* and *A. compressa.*

Orbulina universa.‡—The life-history of this foraminifer has been a subject of much discussion. Pourtalès and Krohn both observed what was apparently a *Globigerina* in the interior of many *Orbulinæ*, and came to the conclusion that *Orbulina* was merely a stage in the life-history of *Globigerina;* this opinion was combated by Carpenter, who adduced numerous reasons for retaining the two genera *Orbulina* and *Globigerina* as defined originally by D'Orbigny.

C. Schlumberger, in numerous specimens of *Orbulina universa* dredged during the voyage of the 'Talisman' from a depth of about 2000 fathoms, observed the same phenomenon; of the smaller examples some contained within their cavity a "succession of globular chambers, arranged in a spiral fashion, like those of certain *Globigerinæ*," while others did not contain any trace of such a structure; the very large specimens also were nearly always empty.

On examining with care this *Globigerina*-like body its "plasmostracum" was found to be extremely fine, and traversed by widely scattered perforations; the chambers forming the two first turns of

* Journ. de Microgr., viii. (1884) pp. 317–31 (2 pls.).
† Zool. Anzeig., vii. (1884) pp. 91–5.
‡ Comptes Rendus, xcviii. (1884) pp. 1002–12.

the spiral are quite smooth, whereas the following ones are provided with spines which reach as far as the outer wall of the *Orbulina* and are there fixed firmly to it; the several chambers communicate with each other and also with the interior of the *Orbulina*.

Now in an independent *Globigerina* the plasmostracum is always relatively thick, the perforations are close together, in short, it differs in many respects from this *Globigerina*-like body with which it only agrees in a general similarity of form.

It appears, therefore, that the most probable explanation is that *Orbulina* is another instance of dimorphism among the Foraminifera such as has already been shown to exist in other genera of that order by the author and M. Munier-Chalmas.

Nuclear Division in Actinosphærium eichhornii.*—A. Gruber has a note on R. Hertwig's observations on the division of the nucleus of this Protozoon. In the resting nucleus Hertwig distinguishes a nuclear membrane, which is best seen after the addition of reagents, the nuclear substance, and the framework of achromatic substance therein suspended. In the nucleolus there may be distinguished from the nuclein (chromatin) paranuclein which does not take up colouring matter and is much smaller in quantity; the nucleolus varies greatly in form, and may become completely broken up into two or more nucleoli; there are often as many as six or even twenty, and they then form fine rods united into a rosette.

When the nuclei begin to divide there appear two special protoplasmic cones, which lie outside the nucleus, and which, though they give rise to a spindle-shaped body, are clearly not the so-called nuclear spindles. The nucleolus next begins to break up, and the nucleus forms a sphere filled with regularly distributed and very fine granules; these pass to the periphery, where they give rise to two hyaline caps and an equatorial band of granules. In this last there appears a dark band, the nuclear plate, and in the rest of the granular mass fine filaments which give rise to the polar plates. These filaments traverse the nuclear plate and so form a system which extends directly from pole to pole. Lateral plates become formed which have the concave side directed towards the centre of the mass, and from these arise daughter-nuclei which form small, rounded, finely granular bodies.

It is clear from these observations that the nuclein in the nucleus of *Actinosphærium* is not a spongy framework; the processes described are intermediate between the phenomena which obtain in other Protozoa on the one hand, and in animal and vegetable cells on the other. As in the former, the nucleus is sharply limited at every stage of division, and undergoes a biscuit-like constriction; the internal changes remind one rather of what obtains in multicellular organisms. The remarkable polar plates find their homologues in the nuclei of the infusorian *Spirochona gemmipara*. Gruber ascribes the errors in his own previously published observations to the imperfect preservation of the material with which he had to work.

* Biol. Centralbl., iv. (1884) pp. 233–5.

BOTANY.

A. GENERAL, including Embryology and Histology of the Phanerogamia.

Homology of the Reproductive Organs in Phanerogams and Vascular Cryptogams.*—L. Celakovsky has made a fresh detailed investigation of this subject. He maintains his previous view, held also by Warming and Prantl, of the homology of the integuments of the ovule with the indusium of ferns, as is sufficiently proved by the phenomena of phyllody of the ovule, which show that the ovule is due to a transformation of a segment of a fertile leaf together with the nucellus or macrosporangium belonging to it; the integuments being formed from it in just the same way as the indusium from the fertile leaf-tip of the Filicineæ. The nucellus is formed directly from the upper part of the ovular papilla; the integument then springing from its base and enveloping it; this being followed in most cases by a second envelope formed in the same way outside the first. The nucellus being homologous to a sporangium, the mode of formation of the ovule coincides with that of the sporiferous leaf-segment of *Lygodium*, the sporangium of *Lygodium* being formed at the apex of a segment of a fertile leaf, just like the nucellus on the ovular papilla, and the indusium round the sporangium just like the single or double integument round the nucellus. In *Trichomanes* the only difference is that the sporangium is replaced by the sporiferous receptacle. When normally dichlamydeous ovules undergo phyllody, they become monochlamydeous, and form a simple stalked cup which corresponds to the integuments, the stalk corresponding to the funiculus. The nucellus sometimes occupies its normal terminal position at the bottom of the cup, sometimes it is pushed towards its rim. The segment of a fern-leaf which bears the indusium on its under side corresponds to the outer ovular integument in Angiosperms.

In the Hymenophyllaceæ the indusium is not formed from the apex of the leaflet which corresponds to the nucellus or receptacle of the sorus, but as a lateral new formation. The single terminal sporangium appears to be more archaic than the polyangic sorus with its receptacle. The author believes that the sexually produced generation (non-sexual generation) of the first Vascular Cryptogams originated from the branching of the sporogonium of a moss. The sporangium of ferns is then homologous, from a phylogenetic point of view, to the sporangium of mosses, notwithstanding its different morphological value. The sporangium of Schizæaceæ is an older stage of development, and that of Ophioglossaceæ older still, where the integuments are entirely wanting, and the sporangium is therefore formed from the greater part of the leaflet, perfectly homologous to the naked ovule of the Santalaceæ, Balanophoreæ, and *Crinum*.

* Pringsheim's Jahrb. f. Wiss. Bot., xiv. (1884) pp. 291–378 (3 pls.).

The original position of the nucellus on the leaf-segment is always terminal; but as soon as the leaf-segment assumes a foliar character, it takes its place on its upper side; and this is a universal law for vascular cryptogams and phanerogams alike.

If we now look at the homologies of the reproductive organs outside the true Filices, we see that the fertile leaves of cryptogams with marginal sporocysts, like *Botrychium* and *Ophioglossum*, are the prototype of the carpids of Phanerogams with marginal ovules; and that the fertile leaf of *Lycopodium* with axillary or subaxillary sporocyst, is the prototype of a carpid with axillary ovule, like *Euphorbia* and *Ranunculus;* and that this is also the case with a carpid with ovule terminal to the axis of the flower, like *Polygonum*, which, notwithstanding this position, undoubtedly belongs to a carpid of the ovary.

With regard to the phenomena of coalescence in the various groups, Celakovsky makes the following observations:—

1. In Angiosperms the trumpet-shaped carpellary leaves of a flower coalesce into a septated ovary. 2. In Marsileaceæ the cornet-shaped leaf-segments of a fertile leaf coalesce into a 2- or multilocular sporocarp, the homologue of an integumented ovule. 3. In Psiloteæ the sporangia coalesce with one another as the homologue of a branched but naked ovule. In Marattiaceæ the numerous emergence-like sporangia coalesce into a multilocular homologue of coalescent nucelli of an ovule.

As regards the ovules of Gymnosperms, those of Cycadeæ are distinguished from the homologous sporangia of the Ophioglossaceæ only by being invested with an integument; and their carpellary leaves from the fertile leaves of Ophioglossaceæ only by the latter being bifurcate.

The Coniferæ are divided by Strasburger into two main groups: (1) the Araucariaceæ (including the Araucarieæ, Abietineæ, Cupressineæ, and Taxodieæ), and (2) the Taxaceæ (including the Taxeæ, Podocarpeæ, and Cephalotaxeæ), which differ so greatly in their morphological characters that they must be considered separately.

The ovules of the Araucariaceæ have only a single integument, and spring from the under side of the carpids which coalesce into a fertile scale and stand in the axil of a bract; turning towards it, according to the law of inversion, their upper side, and coalescing with it slightly in the Abietineæ, very closely in the other families. The phenomena of prolification of the cone show that in the Abietineæ the simple scale-like carpels produce each one ovule on its under side. This is a carpel in its simplest possible form, and homologous to the possible case in which the fertile leaf of a cryptogam, e. g. Lycopodiaceæ, should produce a single indusium on its under side. This is also the most probable interpretation of the structure in the Cupressineæ and Taxodieæ, though not so certainly as in the Abietineæ.

In Taxaceæ the ovule has two integuments, except in *Gingko* (*Salisburia*) and *Cephalotaxus*, and is inserted on the upper side of the carpel, sometimes higher, sometimes at the base or in the axil of the leaf. The "cones" of the Cycadeæ, Podocarpeæ, &c., are flowers

composed of carpels, while those of the Araucariaceæ are true spikes, the bracts of which produce the coalescent carpels in their axils.

The mode of formation of the anthers differs in Gymnosperms and Angiosperms. The type of stamen in the Coniferæ and Gnetaceæ is derived from that in the Equisetaceæ, and more remotely from that in the Ophioglossaceæ; the stamens of Cycadeæ corresponding to the more or less peltate type in ferns with sori on the under side, especially in Gleicheniaceæ and Marattiaceæ.

The anther of Angiosperms is developed from a sporophyll of the Ophioglossaceæ, but in a different way from that of Coniferæ, viz. from the form in *Ophioglossum* rather than in *Botrychium* or *Helminthostachys*. The difference between a pollen-sac of Coniferæ and a loculus of the anther of Angiosperms, is that the former is homologous to a single sporangium, the latter to a row of coalescent marginal sporangia. The normal anther of Angiosperms is also distinguished by the peculiarity of having not two but four loculi, as is clearly shown by the phenomena of phyllody of the stamen.

Influence of Light and Heat on the Germination of Seeds.*—A fresh series of experiments on this subject, undertaken by A. Cieslar, leads him to the conclusion that the effect of light on the germination of seeds is very complicated, and varies with the species, depending greatly on the amount of reserve food-material in the seed. The rays of different refrangibility also produce different effects. In white and yellow light much greater development takes place than in violet light or in the dark; and this difference increases with increase of temperature. He believes the effect to be greatly due to a transformation of light into heat. The production of substances which cause osmose in seedlings growing in white or yellow light is favourable to germination, by bringing about increased root-pressure. Seeds with but a small amount of reserve food-material germinate better in light than in darkness; light promoting not only the penetration of the roots into the soil, but also the copious production of roots.

A. Ritter von Liebenberg† confirms these conclusions on the whole, and regards the intermittent heat resulting from alternation of day and night as distinctly favourable to the germination of seeds.

Origin of the Placentas in the Alsineæ (Caryophylleæ).‡—Miss G. Lister, in view of the fact that in *Lychnis* the first developed ovules are developed along the unattached margins of the dissepiments in the upper unilocular portion of the capsule, the placentas being therefore carpellary, considers that as the capsule in Alsineæ is developed on essentially the same plan as that of *Lychnis*, we are bound to admit that the placentas in the Alsineæ, from *Sagina apetala*, which most resembles *Lychnis*, to *Cerastium triviale* which most widely differs from it, are carpellary also.

* Wollny's Unters. aus d. Geb. der Agricultur-physik, vi. (1883). See Bot. Centralbl., xviii. (1884) p. 13.

† Bot. Centralbl., xviii. (1884) pp. 21–6.

‡ Journ. Linn. Soc. Lond.—Bot., xx. (1884) pp. 423–9 (1 pls.).

Gemmæ of Aulacomnion palustre.*—This moss was found in 1882 growing in the propagating pits at Kew, where it flourished without, however, showing any trace of sexual organs. F. O. Bower finds that ordinary vegetative axes often bear towards their apices structures of a foliar nature, and show a special adaptation for effecting the asexual or vegetative reproduction of the plant. On passing upwards along one of these axes or pseudopodia, there is found a gradual transition from the normal leaf to the leaf-gemmæ, which are readily removed from the plant by a slight mechanical disturbance, and are then capable of immediate germination when laid on damp soil or floating in water.

Relation between Increase and Segmentation of Cells.†—Prof. Beketoff criticizes Sachs' theory as to the relations between the increase and segmentation of cells in the embryonal parts of plants. While he warns one against the application of geometrical theories to botany, he points out how some of the conclusions arrived at by Sachs could be more easily explained by the principles established by Hofmeister.

Development of Starch-grains in the Laticiferous Cells of the Euphorbiaceæ.‡—The development of the starch-grains in the laticiferous cells of the Euphorbiaceæ is described by M. C. Potter as taking place in the interior of rod- or spindle-shaped starch-forming corpuscles which lie in the parietal protoplasm of the cell.

The starch-grain is at first visible, through the agency of iodine, as a thin streak in the interior of the starch-forming corpuscle. This streak, through the deposition of starch, assumes a rod- or spindle-shape; it increases in length and breadth, the starch-forming corpuscle at the same time increasing. When the starch-grain has attained nearly to its maximum dimensions in length and breadth, the starch-forming corpuscle collects at both ends of the rod-shaped grains, and there forms the masses of starch at the end of the rod, causing it to assume its remarkable shape, resembling a bone. The starch-grains are doubly refractive, but instead of the black or white cross of other starch-grains they show a central black (or white) line surrounded on both sides by white (or black) lines.

Constitution of Chlorophyll.§—E. Schunck extracts leaves with boiling alcohol, and after some time filters; the filtrate is mixed with its own volume of ether and two volumes of water; it then forms two layers, which are separated. The lower layer is yellow, and reduces Fehling's solution. The upper layer is green, and contains all the chlorophyll; it is thoroughly washed free from everything soluble in water. When the ether is evaporated the bright green residue, dissolved in alcohol and treated with alcoholic potash, does not reduce Fehling's solution, but if it is previously treated with concentrated

* Journ. Linn. Soc. Lond.—Bot., xx. (1884) pp. 465–7 (4 figs.).

† Mém. Soc. Naturalistes St. Pétersbourg, xiii. See 'Nature,' xxix. (1884) p. 461.

‡ Journ. Linn. Soc. Lond.—Bot., xx. (1884) pp. 446–50 (1 figs.).

§ Proc. Roy. Soc., xxxvi. (1884) pp. 183–5, 285–6.

sulphuric acid in the cold, or if its alcoholic solution is boiled with hydrochloric or sulphuric acid, the alcohol driven off, the residue treated with water, filtered, and the filtrate made alkaline, mixed with Fehling's solution and boiled, the usual glucose reaction is obtained. The glucose or glucose-like substance is a pale-yellow gummy compound. The author, therefore, concludes that chlorophyll is either a glucoside, or is associated with a glucoside.

Cellulose accompanying the Formation of Crystals.*—A. Poli has already noted † the occurrence in the pith of a number of plants belonging to the order Malvaceæ, of clusters of crystals attached to the cell-wall by strings of cellulose. He has now examined more closely the structure of these strings, and finds them to be hollow tubes. They generally exhibit swellings here and there, and bright refringent spots, which are probably the points of origin of new crystals. Their composition is the same as that of the cell-wall, and they not unfrequently become lignified in the same way. They appear to occur in all the arborescent species of the order, most beautifully in *Malvaviscus mollis*, but have not been observed in *Malva sylvestris*.

Middle Lamella of the Cell-wall.‡—In the course of his investigations on the continuity of protoplasm through the walls of cells, W. Gardiner has investigated the structure of the middle lamella of cell-walls, formerly known as "intercellular substance." He found the mucilaginous degeneration of the cell-wall to be a phenomenon of very frequent occurrence; and that this mucilage is very liable to be mistaken for protoplasm, owing to its being also stained by Hofmann's blue. In certain cells, such as bast-prosenchyma cells of the pulvini of *Mimosa*, and the endosperm of many palms, the cell-walls consist of pure cellulose, and the middle lamella is but little developed; it is more resistant, but still distinctly soluble in sulphuric acid. In other instances, such as the lignified prosenchyma cells of the cortex of *Lycopodium*, it is well defined, but lignified, like the rest of the layers. In other cases it may be at once converted into mucilage. The great point with regard to middle lamellas other than cellulose is that in their substance the maximum amount of change appears to have taken place, i. e. almost the whole of the cellulose has been converted into lignin, cutin, or mucilage, as the case may be, and thus but little of the cellulose framework left. This will explain the fact that, after treatment with Schulze's mixture or other oxidizing agent, the various cells readily separate from one another; for the whole of the middle lamella has dissolved, the cellulose framework of the cells alone remaining. It would thus appear that in unaltered cellulose walls the middle lamella consists of dense cellulose, while in lignified, cuticularized, corky, or mucilaginous cells the changes which occur in the middle lamella are of the same character as those of the rest of the membrane, and have reached their maximum.

* Nuov. Giorn. Bot. Ital., xvi. (1884) pp. 54–6 (1 pl.).
† See this Journal, ii. (1882) p. 597.
‡ Proc. Camb. Phil. Soc., v. (1884) pp. 1–20.

Intercellular Spaces between the Epidermal Cells of Petals.*—While the cells of the epidermis of leaves fit close to one another without any intervening spaces except the stomata, the case appears to be very different, according to G. H. Hiller, with the epidermis of petals, where there are very often spaces between the cells, especially in Dicotyledons. The size and form of these spaces vary with the species; in *Linum usitatissimum* they have a breadth of from 2·63 to 7·175 μ, and a length of from 13·15 to 15·78 μ. The largest measured had a diameter of 18 μ. They are situated either between the walls of the cells themselves, and then usually at the point of contact of several cells, or in rib-like foldings of the cell-walls. On the inner side of the leaf they are usually open, where not accidentally covered by a parenchyma-cell, while on the outer side they are always covered by the cuticle. They almost always originate from ribs which must be regarded as foldings of the cell-wall, which ribs split at a certain stage of development. Very rarely they occur in epidermis with straight-walled cells, and then always from their effort to round themselves off. They are then always found at the point of contact of several cells. Intercellular spaces of this kind may be observed in the petals of *Musa rosacea* and *Erythrina cristagalli*.

Contents of Sieve-tubes.†—E. Zacharias has examined, by ordinary macrochemical tests, the contents of the sieve-tubes of *Cucurbita Pepo*, which flow out in large quantities when the stem is wounded, and can be readily separated from the cell-sap. They consist of albuminoids, non-albuminous organic substances, and inorganic salts.

The albuminoid substances readily separate from the juice which flows from the sieve-tubes, after standing for a short time, in the form of a transparent, colourless, moderately stiff jelly. Chemical tests show that this substance is of the nature of fibrine, mixed with a small quantity of a substance insoluble in the gastric juice and in dilute potash ley. When this substance has been removed by concentrated alcohol, the filtrate turns the plane of polarization to the right. The substance which remains is of the nature of dextrin, which is transformed into glucose by dilute sulphuric acid. The presence of a nitrate or nitrite can also be determined both in the aqueous solution of the substance and in its ash. The question of the presence or absence of amido-acids and of organic nitrogenous compounds soluble in water in the contents of the sieve-tubes was not satisfactorily settled.

Of inorganic salts there was found in the ash distinct evidence of the presence of magnesia. The probable presence in the sieve-tubes of potassium phosphate was also indicated, and to this is probably due the alkaline reaction of the juice.

Organs of Secretion in the Hypericaceæ.‡—J. R. Green describes the organs that secrete the ethereal oil or resin with which the

* Ber. Deutsch. Bot. Gesell., ii. (1884) pp. 21–3.
† Bot. Ztg., xlii. (1884) pp. 65–73.
‡ Journ. Linn. Soc. Lond.—Bot., xx. (1884) pp. 451–64 (2 pls.).

tissues of the Hypericaceæ abound. He concludes, (1) that the view advocated by Link, Martinet, and de Bary of the lysigenous origin of the reservoirs of ethereal oil in these plants is the correct one. (2) That there exists in many parts of the plants a series of ducts or passages differing only slightly from these reservoirs; the differences being that they are not globular and isolated, but are generally connected more or less intimately with each other, and that their secretion is not a clear ethereal oil, but a viscid or resinous liquid, the points of agreement being those connected with their development and function. (3) In some species at least there is also a series of schizogenous ducts confined to certain portions of the phloëm. (4) There are certain dark glands described in the paper which are in intimate relationship with the fibrovascular system. (5) The formation of resin and kindred secretions in these plants is confined to the parts where metabolism is active, and where there is a primary meristem. All such parts give evidence of such formation with the exception of the roots.

Tracheids of Gymnosperms.*—M. Scheit describes the group of peculiarly thickened cells (the tracheid-seam of de Bary) found in the leaves of conifers on both sides of the vascular bundle, at one time considered as a part of the transfusion tissue. In the living condition these are filled with water or aqueous vapour, but not with air, as is shown by placing twigs of *Pinus Pumilio* in turpentine oil. The cells themselves are true tracheids, exhibiting sometimes a reticulate thickening, sometimes bordered pits. These "seams" occur not only in conifers, but also in the other orders of Gymnosperms, the Gnetaceæ and Cycadeæ, where they consist of very small and few cells, greatly resembling the adjoining parenchymatous cells in the mode of thickening. They are therefore an anatomical characteristic of Gymnosperms generally.

The variation in the mode of thickening in these cells corresponds to their function as a protection against the pressure of neighbouring turgid cells. Where the "seams" are separated from the parenchyma of the leaf by thickened sheaths, the tracheids have only bordered pits; when they are in immediate contact with the parenchyma, they are thickened reticulately. The extent of development of these "seams" depends on the intensity of transpiration of the species. In *Pinus Pinea*, which spreads its crown as wide as possible beneath the clear sky of Italy, they are very strongly developed; while in *Pinus Strobus*, which prefers moist climates and thrives best in bogs, they are but very feebly developed.

Apparatus in Leaves for Reflecting Light.†—O. Penzig has examined the structure of the clusters of crystals found in the leaves of the Aurantiaceæ, clothed with cellulose, and attached to the wall of the mother-cell—the idioblasts of Pfitzer; and believes they are

* Jenaische Zeitschr. f. Naturwiss., ix. (1883) (1 pl.). See Bot. Ztg., xlii. (1884) p. 74.

† Atti Soc. Nat. di Modena, i. (1883) (1 pl.). See Bot. Centralbl., xvii. (1884) p. 333.

connected with the dispersion of the rays of light in the dense palisade-tissue. They always have their principal axis vertical to the surface of the leaf, and are fixed in this position by a peculiar band of cellulose. The rays of light fall, therefore, parallel to the principal axis of the crystals, and are dispersed on all sides from their reflecting surfaces, while those which pass through the crystals are refracted obliquely. It is possible that the subepidermal cystoliths in the leaves of *Ficus* have a similar property.

Swellings in the Roots of Papilionaceæ.*—F. Schindler has reinvestigated this subject, with reference to the previous researches of other observers; and has come to the conclusion that the peculiar swellings are not due to the attacks of a parasitic fungus, but to hypertrophy of the tissue surrounding the vascular bundles, though in some cases there appears to be a phenomenon akin to symbiosis. The species in which the peculiar structures were observed, were *Trifolium pratense*, *Vicia villosa*, *Phaseolus vulgaris*, and *Lupinus*.

Origin of Adventitious Roots in Dicotyledons.†—A. Lemaire discusses Van Tieghem's statement that lateral roots have their origin in the peripheral layer of the central cylinder which he denominates the pericycle, and points out that all Van Tieghem's examples are drawn from Monocotyledons. Lemaire finds among Dicotyledons two types, the first in which they spring from interfascicular spaces, the second from the pericycle, or layer of the central cylinder immediately beneath the endoderm. In the latter case they are always produced in the neighbourhood of large primary bundles. The cellular portion of the pericycle of two plants examined (*Mentha arvensis* and *Veronica Beccabunga*) divides by tangential walls into two layers, the inner of which produces the central cylinder, the outer one again dividing into two layers. The lower of these gives rise to the cortex, while the peripheral layer developes, by successive divisions, into the cap and piliferous layer of the root.

Crystals of Silex in the Vascular Bundles.‡—Pursuing the researches of G. Licopoli, R. F. Solla has examined the clusters of siliceous crystals found in the fibrovascular bundles of a number of species of palm, especially *Chamærops humilis* and *Phœnix dactylifera*. He finds them in rows in the immature fruit of the first-named and in the trunk of the last-named species, in the latter case occurring also in the vascular sheath. They are found also in the sclerenchymatous cells in the endosperm of the seeds of *Chamærops humilis*, and in the spathe of *Cocos Yatai*. They vary greatly in size according to the species; their chemical reactions show them to consist of pure silica.

Effect of Heat on the Growth of Plants.§—Following out his researches on this subject, J. Wortmann gives the minimum, the optimum, and the maximum temperature for growth in various plants. As a general law, it may be stated that thermotropism is a phe-

* Bot. Centralbl., xviii. (1884) pp. 84–9. Cf. this Journal, iii. (1880) p. 115.
† Bull. Soc. Bot. France, xxx. (1884) pp. 283–5.
‡ Nuov. Giorn. Bot. Ital., xvi. (1884) pp. 50–1.
§ Biol. Centralbl., iv. (1884) pp. 65–71. Cf. this Journal, iii. (1883) p. 873.

nomenon of irritation altogether analogous to heliotropism, and that hence, in order to bring about thermotropic curvatures, the only factor to be regarded is the direction in which the rays of heat, if of sufficient intensity, strike the part of the plant in question.

Curvature of Roots.*—J. Wiesner has made a further investigation of the "darwinian" and the geotropic curvature of roots, with the following results:—

1. The so-called "darwinian" curvature of roots, caused by injury to one side of the apex, has a double character, a secondary curvature taking place above the maximum zone of growth, while the primary curvature is below it.

2. The primary curvature is the result of growth, the secondary curvature simply of turgidity, the cells above the injured spot increasing in length. If the root is decapitated, the zone above the wound, within which the darwinian curvature takes place, is elongated, the cell-walls becoming more extensible.

3. The darwinian curvature combines with other paratonic nutations, as for example with geotropic curvature. Geotropism frequently neutralizes the darwinian curvature.

4. The entire growth of decapitated roots grown in damp media is less than that of those that remain uninjured; while the lower zone of such roots nearest the apex undergoes great extension in consequence of the increase of extensibility of the cell-walls. In decapitated roots grown under water this pathological increase in length is so great that the total growth of such roots is greater than of unmutilated ones.

5. The decapitation of roots causes a diminution of the turgidity of the cells; and since geotropic curvature decreases with this diminution, it follows that decapitated are less geotropic than uninjured roots.

Torsion as a Cause of the Diurnal Position of Foliar Organs.†—According to O. Schmidt, light, by promoting the growth in length of the shaded side of organs, can produce curvatures, but not torsions. So-called heliotropic torsions are due to the action of gravitation. The ordinary diurnal position of leaves is a result of the combined action of light and of gravity, the latter causing the torsion without which the position could not be attained.

Assimilative Power of Leaves.‡—J. Sachs has carried out a series of experiments on a number of plants growing in the open ground, for the purpose of ascertaining the phenomena connected with the formation of starch in the chlorophyll-grains, and its disappearance under normal conditions of vegetation. The results arrived at are very remarkable, in showing the extraordinary rapidity with which starch is formed and again disappears when the conditions of vegetation are favourable. The plan pursued was to remove the chlorophyll by alcohol, and then employ the iodine test to determine the presence of starch. Leaves may be perfectly decolorized by first boiling in

* Anzeig. K. Akad. Wiss. Wien, 1884. See Bot. Centralbl., xviii. (1884) p. 95.
† Ber. Deutsch. Bot. Gesell., i. (1883) pp. 504–11.
‡ Arbeit. Bot. Inst. Würzburg, iii. (1884) pp. 1–33.

water for a few minutes, and then for a short time in alcohol. If then placed in a strong alcoholic solution of iodine, the decolorized leaf will be stained a buff-yellow if no starch is present, blue-black if starch is present in great quantities, with intermediate shades according to the amount of starch.

The formation of starch is entirely dependent on the presence of light; and Sachs's experiments show that the starch formed during the day may disappear completely during the night; the cells of the leaves being full of starch in the evening and quite empty in the morning, when the conditions of temperature are favourable. It is stated that the starch disappears in the form of soluble glucoses, which travel, through the vascular bundles, to the parts where they are wanted for purposes of growth. Although this process takes place chiefly in the night, it is also going on more slowly through the day, but is then masked by the much more energetic production of starch. The transformation of starch into sugar may possibly be due to the presence of a diastatic ferment in the cells of the leaf.

By an ingenious contrivance the quantity of starch produced and converted into glucose was approximately measured. In *Helianthus annuus* 4·64 grms. disappeared in ten hours from 1 sq. m. of leaf-surface; and in the same plant 9·14 grms. were formed in the same time on the same area. In another case, where the leaves were removed from the stem to prevent the return of the starch from the leaf to the stem, a sq. m. was found to produce starch at the rate of 1·648 grm. per hour. As a general result, Sachs concludes that, in ordinary circumstances, a leaf may produce in the day from 20 to 25 grms. of starch per sq. m. of surface; and under certain conditions it may even be larger.

Quantitative Relation between Absorption of Light and Assimilation.*—T. W. Engelmann gives the result of a number of observations on this point, accompanied by mathematical formulæ. He regards the bacteria-method † as far the most exact for the purpose. The general results may be stated as follows:—The absolute minimum of absorption lies in the outermost red. Between B and E, to the highest degree at F, lie one or more maxima and minima. The amount of absorption increases constantly, attaining its maximum in the more refrangible part of the visible spectrum. The amount of assimilation corresponds to the amount of absorption in all cases from the outermost red to the green; while in the more refrangible part the amount of assimilation falls notwithstanding a regular increase of absorption.

Causes which Modify the Direct Action of Light on Leaves.‡—Pursuing this subject, E. Mer arrives at the following conclusions:—

1. The position of leaves is not always an index of their direct relation to light; for this sometimes results from influences which modify more or less the direct action of light.

* Bot. Ztg., xlii. (1884) pp. 81–93, 97–105 (1 pl.).

† See this Journal, iii. (1883) p. 390.

‡ Comptes Rendus, xcviii. (1884) pp. 836–8. Cf. this Journal, iii. (1883) p. 386.

2. The diurnal sleep of leaves must not always be regarded as a result of this action acquired to protect them from too great radiation; for if, in certain cases, either their position or the direction of the rays of light is changed, they do not again place themselves in a position to be illuminated by the most oblique incidence.

3. The terms diaheliotropism and paraheliotropism, employed in their wide signification, must therefore serve only to indicate the positions of leaves in reference to the direction of the rays of light, without expressing an opinion on the causes which produce them.

Respiration of Leaves in Darkness.*—G. Bonnier and L. Mangin find that, in the case of green leaves growing in darkness, the same law of respiration prevails as in organs destitute of chlorophyll, viz. that the relationship between the volume of carbon dioxide given off and that of oxygen absorbed is constant, whatever the temperature, both increasing rapidly with rise of temperature.

Movements of the Sap in the Root-tubers of the Dahlia.†—K. Kraus has confirmed the remarkable observation that a tissue with acid sap may exude an alkaline fluid or at least one that becomes very rapidly alkaline. The absorption of water by the tubers of the dahlia takes place not at all or very slightly through the surface, but almost entirely through the roots which are produced in abundance in October and November. An abundant "bleeding" or exudation of sap takes place from uninjured leaves and from the axils of the leaves; also from transverse sections, which ceases as soon as the tubers are deprived of their roots.

There is not in the tubers any sharp distinction between the medullary rays and the xylem-parenchyma, the mass of the root consisting mainly of rows of radially elongated parenchymatous cells. There are, however, darker portions composed of tracheids surrounded by a sheath of thick-walled parenchyma, corresponding to the "fibre-cells" of normal wood. When the tubers are cut off sap exudes especially from the periphery of the xylem, most abundantly on transverse and tangential sections, and proceeding mostly from the closely inclosing parenchyma, partially also from the sieve-tubes and pith. That which exudes from the sieve-tubes is alkaline, from the wood and pith acid; inulin was also detected in it. The cause of this exudation of sap the author regards to be tension of the tissues. After the alkaline "bleeding" from wounded tubers has ceased, the formation of cork commences on the wounded surfaces. The alkaline reaction is probably the result of decomposition.

Absorption of Water by the Capitulum of Compositæ.‡—A. Burgerstein notices that the flowers of Compositæ possess the faculty of absorbing water from without through the epidermis; and that the under side absorbs water more rapidly than the upper side.

* Comptes Rendus, xcviii. (1884) pp. 1064–7.

† Wollny's Forsch. aus dem Geb. der Agricultur-physik, vi. (1884). See Bot. Centralbl., xviii. (1884) p. 65.

‡ Ber. Deutsch. Bot. Gesell., i. (1883) pp. 367–70.

Measurement of Turgidity.*—H. de Vries applies the term "isotonic concentration" to the degree of concentration of different solutions in which they attract water with equal force. The strength of a solution of potassium nitrate, which has the same affinity to water as the solution to be examined of any other substance, is termed the "nitre-value" of that substance. Representing the attractive force of a solution of potassium nitrate at 3, the numbers 2, 3, 4, or 5 might express that of other solutions. These numbers, representing the attractive force for water of a molecule of the substance in question in a dilute aqueous solution, are the isotonic coefficients of the different substances.

The author describes in detail three methods of determining the isotonic coefficients of a substance:—(1) The plasmolytic method, by placing as similar pieces as possible of the tissue in solutions of different concentration of the substance in question and of potassium nitrate, and observing the degree to which the parietal protoplasm is detached from the cell-wall. This method can be applied in the case of only a few plants. (2) The method of plasmolytic transport: by measuring under the camera the plasmolysis which occurs on placing the preparation in a solution of a salt which causes moderate plasmolysis; then transferring to solutions of different concentration of other salts, and again observing the plasmolysis. (3) The method by tension of tissue, by observing the curvature of split terminal portions of shoots in concentrated solutions of the substance to be examined.

By turgidity the author understands the affinity of the dissolved substance for water, and gives detailed results as to the proportion of the turgidity due to the different constituents of the cell-sap, the most important of these in this connection being sugar, oxalic acid, and malic acid. Since the turgidity is constantly being changed by substances out of which protoplasm is developed, the inquiry is one of great importance in vegetable physiology. As a general rule, the author finds the isotonic coefficients nearly to correspond for members of the same chemical group.

B. CRYPTOGAMIA.

Cryptogamia Vascularia.

Origin of Roots in Ferns.†—Lachmann has studied the cauline fibrovascular system of the ascending rhizome of *Aspidium Filix-mas*, which forms a network of hexagonal meshes, from the periphery of which spring the foliar and radical bundles. The former are from five to seven in number, one, medio-dorsal, springing from the bottom of the network, the others inserted symmetrically on its borders.

* Pringsheim's Jahrb. f. Wiss. Bot., xiv. (1884) pp. 427–601; also Vers. Med. K. Akad. Wetensch. Natuurk., xix. (1883) pp. 314–27. See Bot. Centralbl., xvii. (1884) p. 170.

† Comptes Rendus, xcviii. (1884) pp. 833–5.

The radical bundles are always three in number, one median inferior and two lateral, placed symmetrically on the lower half of the network. The lower radical bundle always springs from the upper extremity of a vertical bundle of the stem, inserted on its outer side, almost always exactly in the middle, and often a little lower than the medio-dorsal foliar bundle. From this point it rises obliquely in the cortex, and after passing from 5 to 7 mm. bends, becomes thinner, and goes out at the base of the petiole with the roots of which it forms the central cylinder.

This inferior radical bundle is almost always absolutely independent, but this is not always the case with the lateral radical bundles. These latter have often a common point of departure with the lower lateral foliar bundles, to which they may adhere for a length varying from 2 to 4 mm.; but the portion of this common base which belongs to the radical bundle is generally clearly to be distinguished from that which belongs to the foliar bundle, and sometimes the two bundles are altogether distinct from their insertion. These lateral roots behave differently from the inferior root; after an oblique course they pierce in the same way the cortex of the petiole, the superficial layers of which form a cushion round their base.

The examination of other ferns confirmed the view that in the radical bundles we have a simple coalescence of two bundles originally distinct.

In all Polypodiaceæ the adventitious roots spring from the cauline network, and not from the base of a foliar bundle, even in those species where, in the adult state, coalescence frequently occurs.

Monograph of Isoeteæ.*—L. Motelay and Vendryès publish a monograph of the existing species of Isoeteæ, founded on the materials left by Durieu.

Systematic Position of Lepidodendron, Sigillaria, and Stigmaria.†—B. Renault maintains his previous view as to the relationships of these fossil organisms, against the objections of Williamson and Hartog. He considers that those Sigillariæ which can be determined with certainty belong to the Gymnosperm type, while the species of *Lepidophlois* have the characteristics of Lycopodiaceæ. The Stigmariæ must be regarded partly as rhizomes of Gymnosperms; the anterior portions must have had only leaves with monocentric vascular bundles, the anterior part, after the fall of the leaves, only adventitious roots with tricentric vascular bundles; while in the middle were both roots and leaves. This may serve to explain the conflicting descriptions of various writers.

* Actes Soc. Linn. Bordeaux, xxxvi. (1883) (10 pls.). See Flora, lxvii. (1884) p. 47.

† Renault, B., 'Considérations sur les rapports des Lépidodendrons, des Sigillaires et des Stigmarias,' 32 pp. (1 pl.) 1883. See Bot. Ztg., xlii. (1884) p. 139.

Muscineæ.

Variations in Sphagnum.*—C. Jensen discusses the causes of the great disposition to vary displayed by the different species of *Sphagnum*, and attributes it, in the first place, to the influence of water, and secondarily to variations in the light, temperature, and in the nature of the soil.

When the plant grows completely submerged, all the parts are larger and longer; the stem-leaves become larger, as also do their hyaline cells, which are often provided with pores and spiral thickenings; these leaves then resemble those of the branches in their structure. Those branches which depend from the stem, forming an envelope round it, lose this structure and grow like the other branches, the fertile branches become longer, and are often inserted at a greater distance below the apex of the stem; the bundles of the branches stand at a greater distance apart.

Plants growing in a dryer situation are, on the contrary, more compact, with shorter stems and crowded short erect branches with closely adpressed leaves, as is especially seen in arctic forms.

When the moss grows in the shade it is of a brighter green and stronger growth. The fertile branches may be inserted beneath the apex of the stem, and are then somewhat elongated.

Forms sometimes occur with sickle-shaped branches, and others which resemble the extra-European species in having the stem-leaves of nearly or quite the same structure as those of the branches. These usually occur in dry places, but sometimes also in water.

Fungi.

Sexual Reproduction in Fungi.†—H. M. Ward gives an elaborate *résumé* of the facts at present known respecting sexual reproduction in the various classes of fungi. He points out that—at all events if the Basidiomycetes are set aside—the absence of sexual organs appears to be in direct proportion to the degree of parasitism developed by the fungus. There can be no doubt that the efficacy of any act of impregnation depends on some essential difference in the nature of the protoplasm of the two cells; that, in an oosphere, for example, the molecular energy of the protoplasm is less than that of the rest of the plant for the time being, and that the access of the antherozoid reinvigorates the sluggish mass, causing the renewal of active life. The dormant interval which frequently intervenes between impregnation and germination may be occupied by molecular rearrangements in the mass. The difference in the nature of the male and female protoplasm is indicated by the attractive force which the female frequently appears to exercise on the male element, as in the case of *Œdogonium*. The reinvigorating effect of the male protoplasm may last through many generations. The fact of the sexual organs having

* Bot. Tidsskr. Kjöbenhavn, xiii. (1883) pp. 199–210. See Bot. Centralbl., xvii. (1884) p. 267.

† Quart. Journ. Micr. Sci., xxiv. (1884) pp. 262–310.

partially or entirely disappeared in certain classes of fungi may be explained on the hypothesis that the very strong development of their parasitic character enables them to supply themselves abundantly with food-material at the expense of the host, without any very great consumption of vital energy, and thus renders unnecessary the re-invigoration of the protoplasm, which is the main object of sexual reproduction.

Life-history of Æcidium bellidis DC.*—C. B. Plowright has experimented on the *Æcidium* of the common daisy, and considers that it is not a mere variety of *Æcidium compositarum* Mart., but a true heterœcismal Uredine, differing from its allies in the time that it appears.

Structure and Affinity of Sphæria pocula Schweinitz.†—Dr. M. C. Cooke describes the structure of this species, and shows that it must be relegated to the genus *Polyporus*, to which indeed it was formerly referred by Berkeley and Curtis, though the fact appears subsequently to have been forgotten.

Sphæroplea.‡—Under the designation var. *crassisepta* E. Heinricher describes a var. of *Sphæroplea annulina* with thicker septa than the ordinary form. Hæmatoxylin revealed the presence of a number of nuclei in the cells, sometimes as many as 60, viz. from 1–4 in connection with each ring of protoplasm. In the female cells a portion of the protoplasm collects round each nucleus to form an oosphere, the number of which therefore corresponds to the number of nuclei. The formation of antherozoids is accompanied by a great and rapid multiplication of nuclei, one nucleus being finally contained in each antherozoid. The oospores germinated in the dark, producing swarm-spores, from which new individuals sprung, but this latter germination was dependent on the presence of light.

New Parasite on the Silver-fir.§—Under the name *Trichosphæria parasitica*, R. Hartig describes a parasitic fungus which has been for some years very destructive to the pine-forests in the Neuburger forest. The colourless mycelium attacks the young branches and the leaves, covering the lower side with a weft of threads, and forming bluish white cushions on both sides of the leaves, on which the perithecia appear in autumn. The black globular perithecia are covered in the upper part with numerous long hairs, and have a diameter of 0·1–0·25 mm., or of 7 mm. including the hairs. The asci are about 8·0 μ in length, and completely disappear after the ripening of the spores. The spores are smoke-coloured, usually 4-locular, straight, or somewhat curved, and from 15–20 μ long. The formation of the asci is preceded by that of very small rod-shaped cells, possibly spermatia.

* Journ. Linn. Soc. Lond.—Bot., xx. (1884) pp. 511-2.

† Ibid., pp. 508-11 (1 pl.).

‡ Ber. Deutsch. Bot. Gesell., i. (1883) pp. 433-50 (1 pl.). Cf. this Journal, iii. (1883) p. 888.

§ SB. Bot. Verein München, No. 13, 1883. See Bot. Centralbl., xviii. (1884) p. 62.

Micrococcus prodigiosus within the Shell of an Egg.*—F. Ludwig describes a hen's egg the albumen of which was throughout of a rose-red colour. The absorption-spectrum agreed altogether with that of the colouring matter of *Micrococcus* (*Monas*) *prodigiosus*. The fungus must certainly have been present in the albumen when in a raw state.

Photogenous Micrococcus.†—F. Ludwig has identified the cause of phosphorescence in fish with that of the less common phosphorescence of the flesh of animals used for food, especially swine. It is due to a mucilaginous substance which can be readily wiped off, consisting of micrococci in a state of active motion and division, the characteristic form and arrangement of which are very readily shown by pigments, especially gentian-violet. The zoogloea-colonies are then seen to consist of sharply defined, roundish, densely crowded cells, sometimes isolated, more often associated in beautiful moniliform threads or compact colonies. The diameter of the cells is about 0·5–1 μ. To this organism Ludwig gives the name *Micrococcus Pflügeri*. It can be readily transferred from the haddock or other fish on which it is commonly found, to the flesh of oxen, calves, sheep, swine, &c., producing in it the well-known phosphorescence; it occurs also naturally on crustacea, star-fish, &c.

On the surface of the sea is sometimes found a phosphorescent slime, consisting largely of decaying organic matter, the phosphorescence of which is not due to *Noctiluca* or other animals of that kind; Ludwig attributes it also to this same species of *Micrococcus*.

Respiration of Saccharomyces.‡—M. Paumès has investigated this subject carefully, with the following results:—(1) The respiratory activity of the ferment (*S. cerevisiæ*) decreases as the temperature decreases; (2) in doses of from 1–2 per cent. ether has scarcely any effect on the respiration; (3) in doses of from 3–6 per cent. ether diminishes and even entirely stops the respiration; (4) even by these doses the plant is not killed.

Bacillus of Cholera.§—R. Koch has presented to the German Government six reports on the cause of cholera-epidemic, as the result of investigations on the excreta and on the dead bodies themselves of cholera patients in Egypt and in India, and on the inoculation of other animals with the germs. The internal organs, lungs, liver, spleen, kidneys, &c., as well as the ejecta, were found to swarm with microbia of a great variety of kinds; in all cases was found one definite kind of bacillus, resembling in size and form that of glanders. These were found in largest quantities in the tubular glands of the intestines, especially between the epithelium and the membrane of the gland. Experiments in inoculating other animals with this bacillus yielded only negative results.

* Zeitschr. f. Pilzfreunde, 1883, p. 176. See Bot. Centralbl., xviii. (1884) p. 161.

† Hedwigia, xxiii. (1884) pp. 33–7.

‡ Journ. Anat. et Physiol., xx. (1884) pp. 106–15.

§ 'Erster-sechster Ber. an den Staatssecretär des Innern über die Arb. zur Erforschung der Cholera-Epidemic, von R. Koch.' Alexandria-Calcutta, 1883–4.

Observations on Egyptian ophthalmia showed that two different diseases are ordinarily included under this name; one caused by a kind of bacterium resembling the micrococci of gonorrhœa, the other and less severe one by a very minute bacillus.

The experiments carried on in India determined the presence in the intestines, in all cases of cholera, of the same bacillus as that found in Egypt; and this Dr. Koch has been able to isolate and to cultivate. It then furnished characters in its form and mode of growth in nutrient gelatine, by which it is at once distinguished with certainty from all other known bacilli. This particular form was also never found in the intestines or in the ejecta of those not suffering from cholera. Experiments on the infection with it of other animals had not, up to the time of the publication of these reports, been completely successful.

The cholera-bacillus is not quite straight, like most other bacilli, but is somewhat curved, in the manner of a comma, or even nearly semicircular. In cultivation there often arise S-shaped figures, and shorter or longer slightly wavy lines. They are endowed with active spontaneous motion. They can be best observed in a drop of nutrient fluid attached to the cover-glass, which they are seen to swim through in all directions. In gelatine they form colourless colonies, which are at first close and have the appearance of small fragments of glass, but gradually spread through the nutrient fluid. They have a tendency to collect at the margin of the drop, where their peculiar movements can be well observed, and their comma-like form after treatment with anilin-solution.

As to the question whether their presence is simply due to the presence of the choleraic disease which promotes their growth and development, or whether they are themselves the cause of cholera, Dr. Koch is very strongly of opinion that the latter is the true explanation, since they are never found either in the organs or the ejecta, except in the case of patients who have either died of or are suffering from cholera. They are also found only in that organ which is the seat of the disease, viz. the intestines. In the first feculent ejecta, the bacilli occur only in small quantities; while in the later liquid odourless ejecta, they occur in enormous quantities, all other kinds of bacteria being almost entirely absent; they diminish in number as the excreta become more feculent, and have entirely disappeared when the patient is completely restored to health. Their abundance appears to correspond to the degree of inflammation of the mucous membrane of the intestines, attaining their maximum when this is of a bright-red colour, and the contents a colourless odourless fluid. When the contents become offensive from effusion of blood the bacilli decrease in number and are found only in the vesicular glands and their neighbourhood. Where death results from a secondary complaint following cholera, they are altogether wanting. Their behaviour therefore closely resembles that of all other pathogenous bacteria, their development being proportional to the severity of the disease.

Virus of Anthrax.*—In a preliminary communication, K. Osol describes some experiments, performed in the Pathological Institute of Dorpat, by which he claims to have proved that the bacilli which occur in anthrax are only to be regarded as the secondary products of a chemical virus.

Recounting the previous observations of Professor Semner and of Rosenberger, who claim to have shown the same thing in septicæmia; he states that he himself, in "numerous experiments," thoroughly sterilized, by prolonged boiling, virulent anthrax blood, diluted with an equal bulk of water, which was filtered; the residue again treated with water, boiled and filtered; the filtrate from both, to insure sterilization, was then boiled for two hours on three successive days. Of this concentrated viscid anthrax virus, "large quantities" were injected subcutaneously into rabbits and mice, with carefully disinfected syringes; cultivations of sterilized bouillon were at the same time inoculated each with "one drop" of the same superheated virus; and at the same time control-animals inoculated with *small quantities* of the same, to demonstrate the absence of micro-organisms. As an additional precaution, blood of healthy animals was treated in the same manner as the anthrax blood, and similarly injected in large quantities into rabbits and mice.

The animals inoculated with superheated anthrax blood died in from 3 to 6 days; in about a fourth of the cases typical anthrax bacilli were found in the blood and organs; in the other cases, numerous micrococci, as previously found in anthrax blood by Semner in 1871, and Bollinger in 1872, and shown by them to be a phase of development of the typical bacilli, which has been quite recently confirmed by Archangelski. The blood of animals killed by inoculation with the superheated anthrax virus, when inoculated into sterilized cultivating fluids, developed typical bacilli. Rabbits and mice inoculated with it died of pronounced anthrax, in general with numerous bacilli in the blood, or, in their place, micrococci and "diplococci," which, cultivated, developed to anthrax bacilli. The blood of these animals similarly was fatally infective.

In the control experiments, while animals inoculated with "small quantities" of superheated virus remained perfectly unaffected, cultivations inoculated with similar quantities continued sterile; hence the author claims to have proved that in anthrax blood there is a specific chemical poison, soluble in water, not volatile, of undetermined composition, which, inoculated into other animals, so affects the tissues of the organism that the innocuous microparasites normally present therein, develope under its influence, in from 3 to 6 days, to typical anthrax bacilli in some cases, and in others to an earlier form of the same.

The control-animals inoculated with superheated normal blood were unaffected, save by a slight pyrexia. The author, as he states, from these experiments, does not conclude that the bacilli have no significance or action in anthrax, but, on the contrary, that they alone

* Centralbl. f. d. Med. Wiss., 1884, pp. 401–4.

develope the anthrax virus in the living organism; though they are not the primary but the secondary factor, and derive their virulence, in the first instance, from the action of an unorganized chemical poison.

These conclusions are somewhat out of date at the present time, and misleading. It has been proved to demonstration that in the case of anthrax, the organism does, *per se*, constitute the active contagium. The results obtained by Professor Rosenberger, referred to, have been shown* to have been due to *imperfect sterilization*. In those here described, the absence of infection with small quantities of the superheated virus, and its occurrence with large quantities, shows evidence of the same phenomena; some germs or spores of the bacilli survived the boiling, but these were too few in number to be infectious in every small portion of the fluid, though they were so in large quantities. Were a chemical poison, of which comparatively large quantities are requisite, as asserted, the primary factor in infection, the micro-organisms alone could never be active in unusual quantities, viz. in the 100-millionth of a drop (minim) as has been shown to be the case. The final conclusion of the author here is an obvious paradox, viz. that the micro-organism is at once both cause and effect; it alone produces the virus—a soluble chemical poison—and is produced by it.

Attenuation of Virus in Cultivations by Compressed Oxygen.† —Experiments were made by M. Chauveau with compressed oxygen on the bacilli of anthrax, to ascertain whether their virulence could be modified by its graduated action, as by that of heat and other agents; with the result, at first, that in the case of guinea-pigs the cultivations of the organism exposed to its influence either became more actively virulent at moderate pressures, or at high tension completely inactive; but with sheep, by the action of the agent, the cultivations are modified in their virulence, so that it is not increased by moderate pressure as with guinea-pigs, but on the contrary decreased; and at a point short of that which stops all development of the microbe, spores are formed, which, though still fatal to guinea-pigs, are innocuous to sheep.

At this stage of attenuation, however, they produce a temporary affection, more or less pronounced, in all the sheep inoculated, which passes off within a few days, and the animals are found to have acquired immunity from subsequent infection with the most virulent material; and that by the single inoculation.

This modification of virus is transmissible to cultivations of the second generation, kept at 36–37° C. under normal pressure.

It is, too, very remarkable here, that though usually the blood of guinea-pigs which have died of anthrax is fatally infective to sheep, yet in the case of the former the blood of animals that have succumbed to inoculation with cultivations modified by pressure, is innocuous to the latter, and moreover confers on them immunity from future infection.

Further, these cultivations are so surely attenuated that no single

* Proc. Roy. Soc., xxxiv. (1882) p. 150.
† Comptes Rendus, xcviii. (1884) pp. 1232–5.

animal is killed by them, and the protection they confer is complete, whilst they preserve their properties for several months, and are as effectual with oxen as with sheep.

Cultivation of the virus of other diseases is equally modified by compressed oxygen, as is notably that of swine fever (rouget).

In conclusion, the author trusts that this method of attenuating virus, as yet only tried on a small scale in laboratory experiments, may be rendered generally available in practice, with the immense advantages it offers of (1) immunity conferred by a single inoculation, with (2) perfect safety, and (3) the possibility of using the modified cultivations a considerable time after their preparation.

Rabies.*—L. Pasteur, with the assistance of MM. Chamberland and Roux, has a further † communication on this important subject.

1. If rabic virus is passed from a dog to a monkey, and then from one to other monkeys, it gradually becomes weaker. If it is then injected into a dog, rabbit, or guinea-pig, it remains in this attenuated condition.

2. The virulence of the poison is increased when it is passed from rabbit to rabbit, or from guinea-pig to guinea-pig. If in this "exalted" condition it is passed on to a dog it gives a rabies which is always mortal in effect.

3. Although one can thus increase the virulence of the poison by passing it from one to another rabbit, it is necessary to do so several times if one is making use of a virus which has been attenuated by a monkey.

Thanks to these observations Pasteur has been able to preserve an organism from the effects of more active virus by the use of that which is less so. Here is an example:—Virus, made more powerful by passage through several rabbits, is inoculated into a dog, but as it is inoculated into the dog at every stage of the experiments on the rabbits, the result is that the dog becomes entirely refractory to the poison of rabies.

Pasteur proposes to make the following experiments, of which the first is the most decisive. He will take twenty of his "refractory" dogs and twenty that have not been inoculated; he will let all be bitten by a "mad dog," and he prophesies that his twenty will escape the effects, while the other twenty will exhibit the influences of the poison. A similar set of two twenties will be trepanned by the virus of dogs *à rage des rues*; the twenty vaccinated dogs will resist the poison, the others will die, either mad or paralysed. In a footnote the author points out that of the twenty non-vaccinated dogs, or, as he calls them, witnesses, all will not exhibit the effects of the poison to the same extent, for rabies does not always follow on the bite of a mad dog.

Bacteria in Canals and Rivers.‡—The much-discussed question as to the purification of water in rivers "by itself," that is, by the mere

* Comptes Rendus, xcviii. (1884) pp. 1229–31.
† See this Journal, *ante*, p. 430.
‡ Nature, xxix. (1884) p. 557.

fact of its motion, seems to have entered into a new phase. Dr. Pehl, at St. Petersburg, has recently made a series of bacterioscopic measurements on the waters of the capital, which are summed up in the last issue of the 'Journal of the Russian Chemical Society.' The water of the Neva itself appears to be very poor in bacteria, namely 300 germs in a cubic centimetre. After heavy rains this number rises to 4500, and to 6500 during the thawing of the river. The canals of St. Petersburg, on the contrary, are infested with bacteria, their number reaching 110,000 in a cubic centimetre, even during good weather. The same is true in regard to the conduits of water for the supply of the city. While its chemical composition hardly differs from that of the Neva (by which they are supplied), the number of bacteria reaches 70,000, against 300 in the water taken directly from the river; and the worst water was found in the chief conduit, although all details of its construction are the same as in the secondary conduits. Dr. Pehl explains this anomaly by the rapidity of the motion of water, and he has made direct experiments in order to ascertain that. In fact, when water was brought into rapid motion for an hour, by means of a centrifugal machine, the number of developing germs was reduced by 90 per cent. Further experiments will show if this destruction of germs is due to the motion of the mass of water, or to molecular motion. The germs, among which Dr. Pehl distinguishes eight species, are not killed by immersion in snow. As the snow begins to fall it brings down a great number of germs, which number rapidly diminishes (from 312 to 52 after a three hours' fall of snow, on January 21st, 1884), while their number on the surface of the snow increases, perhaps in consequence of the evaporation of snow or of the condensation of vapour on its surface.

Bacteria from Coloured Fishes' Eggs.*—Dr. Peter has investigated the causes of various colouring of the eggs of *Coregonus Wartmanni*, red, blue, and yellowish-brown, and finds it to be due to the presence of bacteria, which frequently entirely filled up the interior of the egg. The colour itself was due to drops of oil; the bacteria themselves were always colourless, and of the following kinds:—(1) slender smooth motile rods with short segments; (2) thicker motile rods; (3) very thick, straight, smooth, motionless rods (rare); (4) very slender, straight, smooth, motionless filaments; (5) micrococci. There was also not unfrequently a *Saprolegnia* present. These bacteria were cultivated in a large number of different nutrient fluids, when all transitions from them to a spirillum form appeared; as also a transition from the leptothrix form No. 4, to a spirillum. A transformation appears to take place of ordinary bacteria into those which are the cause of the colouring of the eggs.

Bacteria connected genetically with Algæ.†—H. Zukal has continued his investigations ‡ as to the genetic connection between

* Ber. Bot. Verein München, Sept. 19, 1883. See Bot. Centralbl., xviii. (1884) p. 92.

† Oesterr. Bot. Zeitschr., xxxiv. (1884) pp. 7-12, 49-51.

‡ See this Journal, iii. (1883) p. 400.

Drilosiphon and *Leptothrix*, from which, in certain circumstances, bacteria are produced. The filaments of *Leptothrix muralis*, which is very common in greenhouses, forming a gelatinous deposit on the walls, are usually of a light yellow colour; but when, as is frequently the case, they grow among the stems and leaves of mosses, they gradually become green. It must therefore be assumed that there is always in this species of *Leptothrix* a certain amount of green colouring matter,—another illustration of the difficulty of drawing an exact line of demarcation between the Schizomycetes and the Schizophyceæ. It agrees with ordinary Schizomycetes in the capacity for assuming bacterium, bacillus, coccus, and vibrio-forms; and this sometimes takes place even with filaments which are distinctly green.

When a piece of pure leptothrix-jelly is cultivated under water in a glass cell, hormogonia are soon separated, the time of their appearance depending on the temperature of the water. These either again develope into filaments, or pass into the bacterium form or, finally, into the swarming condition. It is usually only the outside filaments which project from the jelly that develope into hormogonia, which either break through the mucilaginous sheath or escape through its open end; on their escape they frequently display movements of circumnutation, due to the contraction of the protoplasm and not to the presence of cilia; the vibrio-form appears, however, to possess cilia, though the author was not able to determine their presence with certainty. The vibrio-form is developed only from a few of the filaments at the margin of the jelly, presenting thus a striking contrast to the true Schizomycetes, in which both the vibrio and spirillum form appear suddenly in large quantities. The bacterium form of *L. muralis* exhibits an evident segmentation, especially after the application of dilute hydrochloric acid or potassium acetate. The hormogonia, when they do not grow into filaments, usually break up into bacteria, which then excrete a thick gelatinous envelope, and swim on the surface of the culture-fluid, a zooglœa family being slowly formed in this way. Less often the bacillus and spirillum forms develope zooglœa colonies. Occasionally, by cell-division within the jelly, the zooglœa acquires the habit of a palmella or merismopædia.

The presence of phycochrome is indicated by the motile hormogonia always collecting on the illuminated side of the vessel. Under certain conditions the bacteria swarm out of the zooglœa-jelly, leaving their membrane behind; the cell-contents arrange themselves in a direction at right angles to the original one, and may develope into the bacillus, leptothrix, or spirillum form, then dividing into bacteria, &c.; but in all the forms the representatives of the last generation are always smaller than the preceding one, finally reaching the limits of vision with the best immersion system.

In addition to the forms above described, *Leptothrix muralis* much less often developes cocci, arranged in a moniliform string, often interrupted by a large strongly refringent cell. Filaments are sometimes found which are segmented above into cocci, below into bacteria.

The formation of cocci indicates a regression to the nostoc form, which is also met with in the history of development of *Drilosiphon*. Resting spores are formed here and there along with the cocci, from 1–1·8 μ in diam.; and these occur also in the bacterium and vibrio forms, in very long threads occasionally two.

The author concluded, as the result of experiments, that *Leptothrix muralis* has no power of inducing fermentation or putrefaction. The presence of free oxygen is absolutely necessary for its growth. It is best cultivated in water containing traces of iron, lime, and potash salts. It is probably capable of carrying on an independent existence; but the presence of vigorous tufts of moss is apparently favourable to its growth.

The micro-conditions of the three principal forms of *Leptothrix muralis*, the leptothrix form with its hormogonia, the nostoc form, and the glœocapsa or palmella form, are morphologically altogether equivalent to true bacteria, but physiologically they are as widely removed from them as any green plant from a non-chlorophyllaceous saprophyte.

Action of Oxygen on Low Organisms.*—F. Hoppe-Seyler has constructed an apparatus for the purpose of testing the influence on the development of the lowest forms of animal life of an abundant or restricted supply of oxygen. He finds that in the presence of free oxygen the only certainly demonstrable products of the decomposition of fluids containing albuminous substances are carbonic acid, ammonia, and water. If the fluid is saturated with oxygen, neither hydrogen nor marsh-gas makes its appearance; the ordinary products of decomposition, indol and skatol, are not formed at all, leucin and tyrosin only temporarily. Microscopic examination shows that when decomposition takes place in the presence of abundant oxygen, the Schizomycetes are formed in much greater quantities than when the supply of oxygen is small. The Schizomycetes and Saccharomycetes behave in just the same way, from a chemical point of view, as all other vegetable organisms, when supplied with abundance of oxygen; they absorb oxygen, and give off carbonic acid, water, and ammonia, or some nitrogenous substance nearly allied to it. In the absence of oxygen all decomposing organisms display fermentation-phenomena; but while the Schizomycetes and Saccharomycetes can remain in this condition for a considerable time, all other organisms perish rapidly in the absence of oxygen. Certain Schizomycetes can sustain the absence of oxygen for a considerable time, especially the one or more species which split up cellulose into CO_2, CH_4, and H_2; but the author altogether disbelieves the theory that there are organisms which can exist only in the absence of oxygen.

Biology of the Myxomycetes.†—E. Stahl has made a long series of experiments on the cause of the movements of the plasmodia of the Myxomycetes, especially of *Æthalium septicum*. By causing one end

* Zeitschr. f. Physiol. Chemie, viii. (1884) p. 214. See Naturforscher, xvii. (1884) p. 116.

† Bot. Ztg., xlii. (1884) pp. 145-56, 161-76, 187-91.

of a piece of blotting-paper, the other end of which dips into water, to come into contact with tan containing plasmodia of the *Æthalium*, he found the latter to display the phenomenon of rheotropism,* i. e. they move to meet the current of water, travelling in a horizontal or even in a vertical upward direction. The same was observed with the plasmodia of a small species of *Physarum*. The plasmodia display not only rheotropism, but also hydrotropism, i. e. movements regulated by the distribution of water in the substratum, when this water is not in motion. During the greater part of the period of development they display positive hydrotropism, or are attracted towards the source of water. They are indeed very dependent on water for their development. On a uniformly moist substratum in an atmosphere saturated with moisture, they spread uniformly in all directions; while in a dry air, when the substratum is gradually drying, they contract, and collect in the dampest spots. Negative hydrotropism does, however, also occur, where the sporangia bend away from the damp spots and stand erect; this was observed, but only rarely, in sporangia of *Physarum*, *Didymium*, and *Æthalium*.

Various chemical substances, such as crystals of sodium chloride, nitre, cane-sugar, grape-sugar, drops of glycerine, &c., exercise a repellent effect on the plasmodia. On the other hand an infusion of tan produced an opposite attractive result; and to this property of moving towards the spots where the supply of nutriment is most abundant Stahl gives the name *trophotropism*. The same substance may have opposite influences of attraction or repulsion according to the degree of concentration of the solution.

As regards heliotropism, the author adds nothing to the facts already known, that plasmodia move from illuminated spots to those that are in shade. He was unable to determine satisfactorily their relation to geotropism; the vertical position of the fructifications of Myxomycetes appears to be due rather to hydrotropism than to geotropism.

With respect to the effect of heat, if *Æthalium* is exposed on the two sides to unequal temperatures, an evident motion takes place towards the warmer side.

Lichenes.

Cephalodia of Lichens.†—Pursuing this subject, K. B. J. Forssell states that the algæ found in connection with cephalodia belong to all the groups of Phycochromaceæ, including the following families:—Nostocaceæ, Sirosiphoneæ, Scytonemaceæ, Chroococcaceæ, and Oscillariaceæ, the first being the most largely represented. The *Nostoc* cells take up very different positions in relation to the gonidial layer of the thallus, belonging to the different kinds of cephalodia already described. Occasionally several species of algæ are found in the same cephalodium.

The development of cephalodia is always the result of the mutual

* See this Journal, *ante*, p. 413.

† Flora, lxvii. (1884) pp. 33–46, 58–63, 177–87. Cf. this Journal, *ante*, p. 100.

action of hyphæ and algal cells; it is not a true parasitism, since the algæ are not destroyed or weakened by the fungal hyphæ; nor can it be regarded as a true example of hypertrophy of the algal cells. There is no struggle for existence between algæ and hyphæ. The author was unable to detect the mode in which the algal cells penetrate into the thallus, but each seems to impart nourishment to the other.

The author regards cephalodia as always the result of an accidental meeting of alga and lichen, the former constituent always belonging to a type of very wide distribution; but there must also always be some power of adaptation of one to the other; some forms of lichen, as *Cladonia*, appear never to form cephalodia. If Schwendener's hypothesis is regarded as one of mutual symbiosis of algæ and fungi, rather than as one of parasitism, then the occurrence of cephalodia supports it rather than otherwise.

Thallus of Lecanora hypnum.*—K. B. J. Forssell describes the somewhat peculiar structure of the thallus of this lichen. It consists of an incrustation of small yellowish-brown rounded granular scales, which do not form a continuous layer, but the whole lichen consists of a complex of individuals more or less cohering in their growth. The scales are of two kinds, one with yellow-green, the other with blue-green gonidia. The author is doubtful whether the latter are to be regarded as cephalodia, or as belonging to a different lichen-species, *Pannaria pezizoides*. Apothecia occur, on the under side of which are sometimes cephalodia containing cells of a *Nostoc*.

Algæ.

Systematic Position of Ulvaceæ.†—The third part of J. G. Agardh's series of Monographs of Algæ is devoted to the Ulvaceæ. Differing from Berthold's view,‡ he places the genera *Bangia* and *Porphyra* among the Ulvaceæ, and not among the Florideæ. In this he relies chiefly on the difference of the reproductive organs in the Ulvaceæ and Florideæ, the former possessing true zoospores, the Florideæ antheridia, cystocarps, and tetraspores. The quaternate division of the cells in the two genera in question he regards as showing an affinity not so much with the tetraspores of Florideæ, as with the mode of division in *Prasiola*, *Tetraspora*, *Palmella*, *Monostroma*, and some species of *Ulva* and *Enteromorpha*. There is also a very material difference in their physiological value, the octospores of *Porphyra* being regarded as sexual, the tetraspores of the Florideæ as non-sexual. There is at present a very considerable divergence between the description by different writers of the organs of reproduction in *Bangia* and *Porphyra*.

The Ulvaceæ are divided by Agardh into eleven genera:—*Goniotrichum*, *Erythrotrichia*, *Bangia*, *Porphyra*, *Prasiola*, *Mastodia*, *Mono-*

* Flora, lxvii. (1884) pp. 187-93.

† Agardh, J. G., 'Til Algernes Systematik:' Lunds Arsskrift, xix. (4 pls.) (Latin). See Nature, xxix. (1884) p. 340.

‡ See this Journal, iii. (1883) p. 408.

stroma, *Ilea*, *Enteromorpha*, *Ulva*, and *Zetterstedtia*. Of these, *Mastodia* and *Zetterstedtia* are natives of the southern ocean; *Ilea* is represented by a single species, *I. fulvescens*, growing at the mouths of some Swedish rivers.

Newly-found Antheridia of Florideæ.*—T. H. Buffham briefly sums up what is known concerning the reproduction of the Florideæ, and gives more particular descriptions of the antheridia of species not figured by Harvey.

In *Callithamnion tetricum* the antheridia appear to be almost terminal, and the principal portion of the mass is on the inner face of the ramulus, which in the specimen figured is bent down by its weight. *Call. byssoideum* has antheridia that are quite hyaline, with the exception of the cellules forming the axis. The antherozoids are very elongated, and their attachment can scarcely be made out. In *Call. Turneri* the antheridia cluster thickly on the ramuli, and are of ellipsoidal form, colourless, and filled with antherozoids. The antheridia of *Call. plumula* are ramose, and occur in clusters, all rising from one cell of the ramulus.

In *Griffithsia corallina* the antheridia cluster round the filament at the junction of two cells.

Figures of the foregoing, as well as of the antheridia of *Ptilota elegans*, *Ceramium diaphanum*, and *C. strictum* are given by the author.

New Unicellular Algæ.†—P. Richter describes the following new species of Algæ (or Protophyta):—*Protococcus gemmosus*, in greenhouses, allied to *P. cinnamomeus*; *Dictyosphœrium globosum*; *Aphanocapsa Naegelii*, in greenhouses; *Aphanothece nidulans*, an extremely minute species, in greenhouses, along with *Protococcus grumosus*; *Oscillaria scandens*, also in greenhouses, possesses a strong smell, somewhat resembling patchouli; *Scytonema Hansgirgianum*, in similar situations, allied to *S. Hofmanni*; *Nostoc Wolluyanum*.

The author states further that his *Aphanothece caldariorum* is the bacillus-form of *Glaucothrix gracillima* Zopf, and is probably identical with *Aphanocapsa nebulosa* A. Br. and *Glœothece inconspicua* A. Br.

Structure of Diatoms.‡—Count Castracane gives a very useful epitome of the chief points in the structure and different modes of reproduction of diatoms.

Belgian Diatoms.§—Dr. H. van Heurck has published the first two sets (including fifty species) of slides illustrating his Synopsis of Belgian Diatoms, determined and described by A. Grunow. The specimens are, for the most part, preserved in the fluid composed and described by van Heurck, compounded of styrax and liquidambar, which has a higher index of refraction than Canada balsam; || a few in solution of phosphorus.

* Journ. Quekett Micr. Club, i. (1884) pp. 337–44 (3 pls.).

† Hedwigia, xxiii. (1884) pp. 65–9.

‡ Castracane, Conte Ab. Francesco, 'Generalità su le Diatomee,' 12 pp. Roma, 1884.

§ Van Heurck, H., 'Types du Synopsis des Diatomées de Belgique,' Série i. et ii. Anvers, 1883.

|| *Infra*, p. 655.

Diatomaceæ from the Island of Socotra.*—F. Kitton gives a list of twenty-two fresh-water species from the Island of Socotra. Amongst these are a new species of *Cerataulus* (*C. Soctrensis*), which is the first fresh-water representative of the genus, and *Fragilaria Ungeriana* Grun., which has previously been found in only two localities—Cyprus and Belgaum (India).

MICROSCOPY.

a. Instruments, Accessories, &c.

Microscope with Amplifiers.—Fig. 89 shows two methods of applying a series of amplifiers to the Microscope:—(1) A disk containing four apertures is mounted above the nose-piece to rotate so as to bring the apertures successively into the optic axis. One aperture is blank for normal examinations; and the others are provided with biconcave lenses of 3 in., 4 in., and 5 in. negative focus respectively. This application of amplifiers was exhibited at the Society several years ago, but we have not succeeded in tracing the name of the exhibitor. (2) Mr. J. Mayall, jun., suggests that the amplifiers should be mounted in a plate (shown in the fig.) sliding through the body-tube, and with means of raising or lowering it within the body-tube so that the best position with each objective may be found experimentally.

Fig. 89.

The use of such amplifiers involves a slight deterioration of the quality of the image, but in many cases this would be more than compensated by the increase in the magnification and in the working distance.

Bausch's Binocular Microscope.†—The following is E. Bausch's specification of his "Binocular Microscope":—

"My invention relates to the class of Microscopes in which part of the rays of light emanating from the object and passing through

* Journ. Linn. Soc. Lond.—Bot., xx. (1884) pp. 513–5 (1 pl.).

† Specification of U.S.A. Patent No. 293,217, dated February 12th, 1881.

the objective are divided by a doubly reflecting prism, known as the 'Wenham prism,' so that one-half of the rays pass to an auxiliary eye-piece mounted in a branch tube applied to the side of the main tube.

In Microscopes of this class the prism has heretofore been mounted in a box arranged to slide laterally in the lower part of the Microscope-body, so that it could be moved into and out of its place by sliding the box, and any imperfection in the bearings of the box, which are necessarily narrow, allowed the box to move laterally, thereby impairing the effectiveness of the instrument. Another serious objection to the common method of mounting the prism is, that the size of tubes in Microscopes being limited, and the box being contained entirely in the tube or nose-piece, the movement of the box and size of the prism are correspondingly limited. This being the case, a large proportion of the rays which are transmitted by modern objectives are prevented from passing to the eye-piece, so that it has frequently been found necessary to remove the nose-piece containing the ordinary prism-box and replace it by another nose-piece which had no obstruction when the full effectiveness of the objective was desired.

My invention is designed to obviate these difficulties by providing a prism-holder with a long cylindrical bearing, which is readily made and practically indestructible by wear, and which admits of either binocular or monocular arrangement of the Microscope with the full effect of either method of vision.

It consists of a prism-carrying arm fixed to the end of a spindle extending through a sleeve passing through the side of the Microscope-body, the spindle being provided with a milled head, by which it is turned, and with a stop-pin, for limiting its motion.

Fig. 90 is a vertical section on the line *x x* in fig. 91 of a portion of a Microscope-body, showing my improvement applied. Fig. 91 is a plan view, partly in section.

The body of the Microscope is provided with a nose-piece A, threaded in the usual way at its lower end to receive an objective, and having sufficient depth to contain the prism-holder B. The prism-holder B consists of a metallic plate *a*, bent twice at right angles, and receiving between its parallel sides *b c* the prism C. The side *c* of the holder B is prolonged, forming an arm *c'* which is secured in any suitable manner to the end of a spindle D. In the present case it is fitted to a shoulder on the spindle and fastened by means of a small nut *d* fitted to the threaded end of the spindle. The spindle D is fitted to a sleeve E, passing through the side of the nose-piece A, so that it may turn therein without lateral or longitudinal motion. To insure the perfect bearing of the spindle D in the sleeve E the sleeve has a longitudinal slit *e*, which permits it to adapt itself to the spindle by springing and to create the small amount of friction necessary to retain the prism-holder in any position. The outer end of the spindle D is provided with a milled head F, by which the prism may be moved into or out of the field, and a pin *f*, projecting from the spindle through a slot *g* in the sleeve E, limits the motion of the prism-holder in either direction. The prism-holder B is arranged relative to the main and auxiliary tubes of the Microscope

so that it will swing in a plane lying in the axes of the two tubes, and when it is swung down into the position shown in full lines in the drawings the prism intercepts one-half of the rays passing through the objective and diverts them to the auxiliary tube. When

FIG. 90.

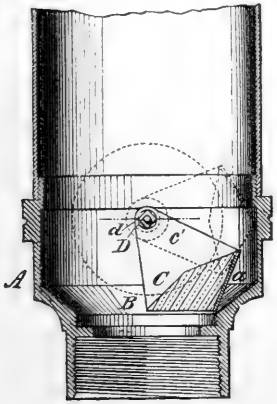
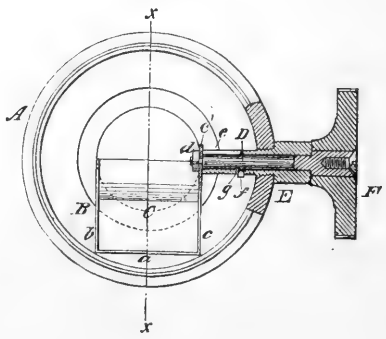


FIG. 91.



the Microscope is used for monocular vision, the prism is turned out of the field, as indicated by dotted lines in fig. 90.

Having thus described my invention, what I claim as new, and desire to secure by letters patent, is—

1. In a binocular Microscope, a swinging prism-holder adapted to support the prism within the body of the Microscope either in or out of the field of vision, as herein specified.

2. The combination, with the doubly reflecting prism of a binocular Microscope, of a prism-supporting arm and spindle attached thereto, and extending outward through the Microscope-body, as described.

3. The combination, in a binocular Microscope, of the prism C, prism-holder B, spindle D, provided with the stop-pin *f*, and the slotted sleeve E, as herein specified."

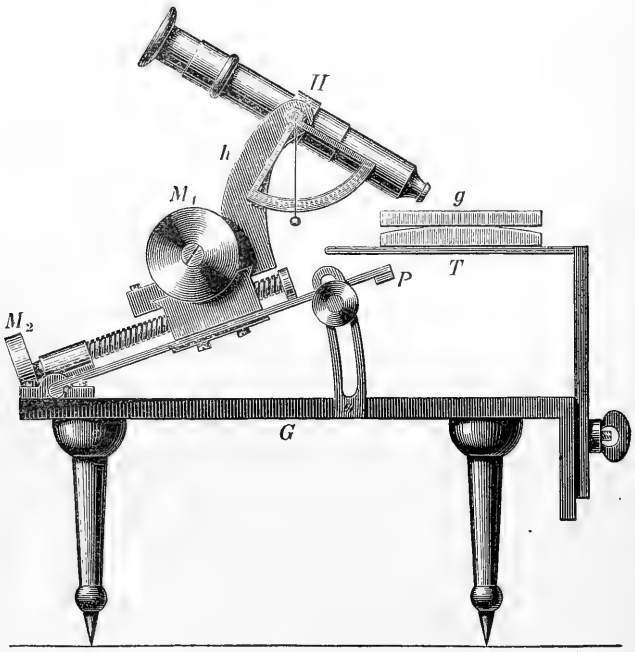
Sohncke's Microscope for Observing Newton's Rings.*—This instrument (fig. 92) is a device of Dr. L. Sohncke for examining Newton's rings, and it is claimed that it fulfils all the conditions in regard to variety of movements (and their measurement) necessary in such an instrument.

The microscope-tube (provided with cross threads and magnifying 20 to 25 times) slides in a short socket H, the former having a scale in half-millimetres (with a nonius on H) for allowing the exact position to be read off. The socket, with the Microscope, can be turned on a horizontal axis, fixed in the front part of two brass

* Zeitschr. f. Instrumentenk., i. (1881) pp. 55–8 (1 fig.).

shoulders *h*, rising from a common base plate. On one side the axis carries a quadrant turning with the Microscope, and having one arm parallel with the optic axis of the Microscope. A plumb line gives the angle on the quadrant. On the other side of the axis is a screw-nut to clamp it in any desired position. The brass base plate to which the shoulders *h* are attached, slides by means of a screw M_1 in a second piece shown in the figure. The motion is at right angles to the plane of incidence of the light falling on the object, i. e. from right to left (or *vice versâ*) as the observer would stand in using the instrument. The second piece is again part of another slide, which

FIG. 92.



is moved backwards and forwards by the screw M_2; the motion here is at right angles to that of the first slide, and therefore parallel to the plane of incidence. The extent of these two movements is read off on two millimetre scales on the guides of the slides, and the screw heads are divided for reading fractional parts of mm. The heavy iron base G of the whole instrument rests upon three feet, and the plane and convex glasses *g* are laid upon a small stage T attached to the front of the instrument, and capable of being raised and lowered above G as required.

Although the apparatus in this form may be thought to fulfil all requirements, Dr. Sohncke considered it especially necessary to add an additional contrivance for indicating, without further measurement, the most characteristic phenomenon in the position of Newton's rings, viz. that those ring-points which are in the plane of incidence passing through the centre of the rings, all lie in a straight line which rises obliquely towards the light. The greatest inclination of this "fundamental line" towards the horizon is 19° 28′. If we have an arrangement by which the Microscope with any angle of incidence can be given a movement parallel to the "fundamental line," then when any one ring (in the central plane of incidence) is clearly seen by proper focusing of the Microscope, all the rings in succession will also be clearly seen by the movement in question; whilst if the Microscope were moved horizontally, they would very soon be out of focus. This requirement is carried out in the present instrument by the guides of the lower slide being fixed, not upon the horizontal base G, but upon the plate P, which is movable on an axis at right angles to the plane of incidence, and can be fixed at any required inclination between 0° and 20°. That the object may not be disturbed by the inclination of the plate, it is cut out somewhat in the shape of a horse-shoe. To use this arrangement the plate P must be placed at the angle ω of the "fundamental line" for the particular angle of incidence θ. The value of ω is obtained from the formula:—

$$tg\,\omega = \frac{\sin\theta \,.\, \cos\theta}{1 + \cos^2\theta}.$$

The Microscope is then to be placed at the required angle of incidence. In order to do this direct, a plumb line, instead of an index, is used for reading off the "angle" on the quadrant, as an index would join in the inclination of the plane P. The lower slide has now only to be moved parallel to the plane of incidence, by means of the screw M_2, in order to see all the rings pass across the field in complete distinctness.

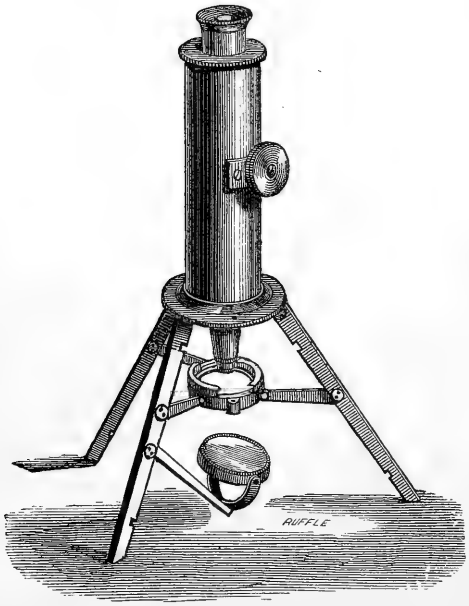
Dr. J. H. L. Flögel describes* a method of determining the thickness of diatoms by the examination of the Newton rings formed when they are illuminated by reflected light from a Lieberkühn. It consists simply in tilting the slide at an angle, the light being admitted to the Lieberkühn through a small excentric aperture in the diaphragm, reaching the objective only after reflection from the preparation.

Harris & Son's Portable Microscope.—This (figs. 93 and 94) is a somewhat ancient form, probably fifty years old, but is arranged on an ingenious plan to secure portability. When set up for use it takes the form shown in fig. 93. By unscrewing the tube, and screwing it into the lower side of the ring which holds it, and closing the tripod legs together, it is reduced to the form shown in fig. 94.

* Arch. f. Mikr. Anat., vi. (1870) pp. 472–514.

The subsidiary leg, which carries the mirror, folds against the leg of the tripod to which it is attached. The stage is removable, leaving

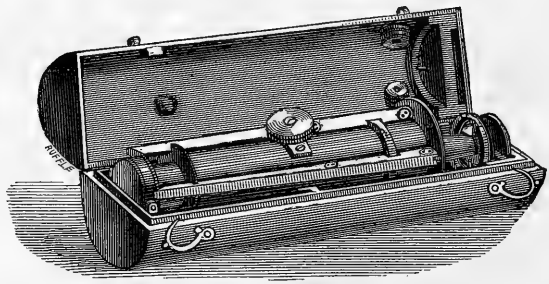
Fig. 93.



a ring, which is attached by three supports to the tripod, and rises and falls somewhat as the tripod legs are shut or opened.

The instrument is hardly so convenient as the modern forms which

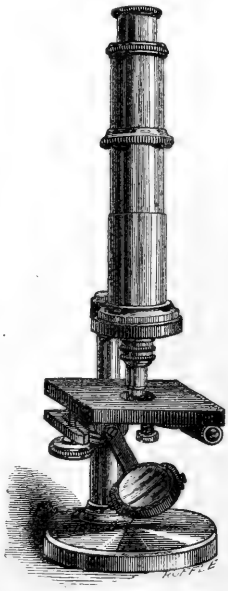
Fig. 94.



have been devised in such profusion, but it is interesting as being a very early progenitor of this class of instrument.

Seibert's No. 8 Microscope.—The Microscope No. 8 in Seibert and Kraft's Catalogue (fig. 95) has a fine adjustment similar in principle to those described Vol. III. (1880) p. 882, though carried out in a different manner. Here the stage is supported on a horse-shoe-shaped frame, and is pivoted to one of the projecting arms. A screw passing through the opposite arm raises the stage at the end and as the screw is withdrawn a spiral spring presses the stage back again.

FIG. 95.

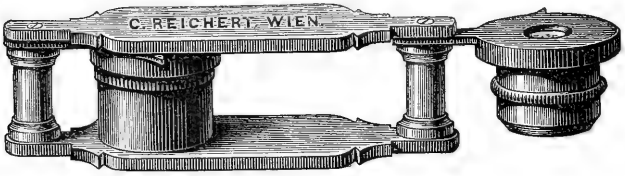


Reichert's Large Dissecting Microscope and Hand Magnifiers.—C. Reichert's large dissecting Microscope (fig. 96) is of exceptional size for the examination of sections of brain and similar large objects. The stage is entirely of glass, and is 11·5 cm. wide and 18 cm. long. The mirror can be moved forwards and to both sides. The preparation is intended to be fixed while the lens is capable of being moved over it in all directions. The arm *a b* can be rotated on *a*, and the lens-carrier *c d* can also be rotated at *b*. By turning the milled head *c* the inner tube *d* which carries the lens is pushed forward or withdrawn again.

FIG. 96.

Herr Reichert also mounts two doublets of 10 and 20 power in a nickelled frame (fig. 97, natural size). When not in use they are

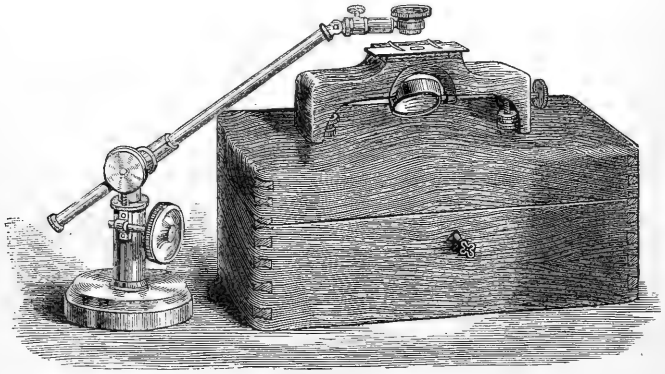
Fig. 97.



turned back within the frame, or for examining an object, brought out as shown in the fig.

Geneva Company's Dissecting Microscope.—This, fig. 98, consists of two parts, a support for the lenses and a stage and mirror.

Fig. 98.



The two are quite separate, a plan which gives more freedom of action than can be obtained in the ordinary form of dissecting Microscope.

The lens-support can be raised by a pinion acting on a rack on an inner tubular pillar. It can also be rotated in a horizontal plane on the top of the latter or in a vertical plane on the pivot clamped by the second (upper) milled-head.

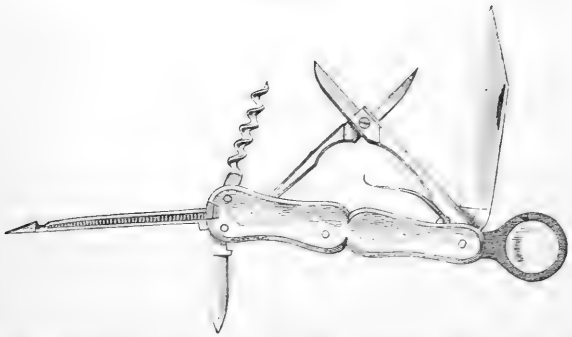
The stage has side rests for the hands and can be screwed to the top of the box holding the instrument. The mirror is rotated on its axis by the milled-head shown on the right. On one side there is an ordinary concave mirror and on the other a plane one of opal glass.

Drallim and Oliver's Microscope Knife.—The following is taken from the advertisement of this knife (fig. 99):—

"It comprises a great variety of articles including a large dagger-blade, small penknife, pair of folding scissors, corkscrew, nail-trimmer and file, tortoise-shell toothpick and ear-scoop, nickel silver tweezers,

and last, but by no means least, a very powerful Microscope. We are not aware of any other knife manufactured which contains a Microscope of any description, and we anticipate an enormous demand in consequence. An ordinary pocket handkerchief submitted to the

Fig. 99.



lens of this powerful glass, the texture appears nearly as coarse as a sack. Scientific students and merchants will find this invaluable to them, as the knife is of convenient size to be carried in the waistcoat pocket."

Ward's Eye-shade.*—Dr. R. H. Ward's device consists (fig. 100) of a circular disk of hard rubber or blackened metal, about $1\frac{1}{2}$ in. in diameter, an extension of which in the form of a band 1/2 in. wide crosses in front of the nose of the observer, but quite out of the way, and encircles the top of the draw-tube or compound body just below the ocular. As now used, this shade is made of hard rubber, which is of light weight, and suitably dark colour, is less likely than metal to scratch the brasswork with which it comes in contact, and is so elastic as to be applicable to a considerable variety of tubes. The same shade, for instance, can be used on tubes of from 1 to $1\frac{1}{4}$ in., or from 1/8 to $1\frac{3}{8}$, the best fit being of a size midway between the two extremes. Besides this easy range of adaptation, this eye-shade differs from those hitherto in use in its attachment to the body instead of the ocular, by which it is brought to an advantageous distance from the face, and is retained in position as long as the instrument is in use, instead of being removed with the ocular and requiring a fresh application every time that is changed. It is reversible by simply turning it over, and can thus be instantly transferred from the left

Fig. 100.

* Amer. Mon. Micr. Journ., v. (1884) pp. 82-3 (1 fig.).

to the right eye, according to the observer's custom of using either eye habitually or both in succession. It is equally applicable to stands whose construction does not admit of its being slipped over the tube from the top; the spring ring at the right of the figure being in such cases made partly open so as to spring on from the side.

Endomersion Objectives.*—Prof. K. W. Zenger claims to have found that perfect achromatism of telescope and Microscope objectives is possible by using a mixture of ethereal and fatty oils, the dispersive power of which for the different rays of the spectrum increases regularly. The disadvantages of the use of fluids are obviated by mixing with suitable salts of the fatty acid series by which nearly hard or gelatinous, vitreous, homogeneous, colourless, and transparent substances are obtained.

The following are extracts from two papers published by the author:—

The construction of achromatic objectives for telescopes, Microscopes, and photography has, from the beginning, presented great difficulties theoretically as well as practically. The dioptrical formulæ which give the equations for the achromatism and aplanatism of the objectives are so complicated that, up to the time of Fraunhofer and the younger Herschel, opticians were content with developing the conditions of achromatism and aplanatism in the axis. In this way, however, a perfect objective was theoretically not to be obtained, and therefore the best makers of that time were obliged to confine themselves to experimental trials.

Herschel and Fraunhofer first showed the way to a more accurate determination of the direction of the rays, and the former has given us a complete theory of telescope objectives, but for the much more difficult computation of Microscope objectives almost nothing has been done, and we to-day still look for a theory of these objectives.

The principal practical difficulty for all kinds of objectives lies in procuring suitable refracting media, because the flint and crown glass, hitherto exclusively used, deviate greatly from the conditions of perfect achromatism. Blair, at the end of the last century, showed the possibility of getting rid of all colour by the use of at least three refracting media, crown glass, oil of turpentine, and naphtha, which give contrary secondary spectra, the dispersive power of one being greater in the red, and of another in the violet part of the spectrum. In this way he succeeded in making an absolutely achromatic objective, the aperture of which was particularly large, namely, one-third of the focal length.

After Blair the matter was lost sight of until the second decade of the present century, when Barlow made an objective of crown glass and a biconcave lens filled with bisulphide of carbon on the dialytic principle. The achromatism of this was not, however, perfect, Blair's use of more than one fluid not having been attended to, and the question again fell into oblivion.

* SB. K. Böhm. Gesell. Wiss. Prag, 1881, pp. 479–92, 467–79 (reversed in order).

Prof. Zenger, in view of Blair's experiments, determined to see whether it would not be possible to find fluids which in combination with crown glass, would produce achromatic objectives. The conditions for absolute achromatism require that the partial dispersions should maintain the same relation in all parts of the spectrum for the two refracting media. Now mixtures of aromatic and fatty substances possess this property to a high degree of approximation, so that when combined as lenses with crown glass (a biconvex crown and a plano-concave fluid) all the different rays of the spectrum will be united and a perfection of achromatism will be produced not hitherto attained.

The question of course arises whether the fluids in consequence of striæ-formations, through rapid changes of temperature, may not originate a new element of optical imperfection. This is opposed to the author's experience of fluid achromatics in sunlight, either with the telescope or Microscope. He has succeeded in converting the ethereal and fatty oils which serve for the production of the refracting media, into the condition of vitreous bodies, or into a kind of gelatine in which striæ-formation is not as easily possible as in very mobile fluids.

By solutions of stearic, oleic, or palmitic acid, or mixtures of these, we can change benzol, castor-oil, poppy-oil and other similar ethereal and fatty oils into transparent gelatine, which is amorphous like glass, perfectly clear and does not flow out of the vessel if inverted. These substances are already used in the arts.

An immense scope for combination is thus opened in order, so to say, to produce kinds of glass of any desired refraction and dispersion, and consequently the optician is saved the trouble of undertaking changes of radius at great expense and loss of time. It is sufficient to make a suitable selection of the gelatine substance which is to be inclosed between a plane parallel plate and the biconvex lens, in order to solve the hitherto difficult problem of a perfect achromatic and aplanatic lens-combination.

The closing up of the fluid must be as hermetical as possible, in order to prevent any evaporation and chemical change in the course of time. There are ethereal and fatty oils which are transparent and very little changeable.

The problems as to lenses for telescopes, Microscopes, and photographic objectives are therefore, it is claimed, extraordinarily simplified through the use of "endomersion" objectives, which are thus named by the author in analogy with immersion objectives, because the fluid is between the lenses. On account of the fact that three radii are equal, while the fourth is infinitely great, he also calls them "symmetrical" endomersion objectives, a quality which embraces the most favourable conditions for brightness, sharpness, and flatness of field of view.

Formulæ and tables are given for the construction of endomersion objectives, and after considering more particularly the case of telescope objectives, those for the Microscope are dealt with, in which case the plane side of the concave fluid lens should be turned to the object.

Such an objective is then somewhat over-corrected, and thus exactly suited for a Microscope objective, because in the case of a single lens the over-correction can be removed by the Huyghenian ocular, while with doublets and triplets, the lens can be corrected or over-corrected to the desired amount, the residue being removed by the ocular as is commonly done by the Lister method.

When the necessary calculation for a given mean refractive and dispersive relation, such as from quartz to a fluid, is once made for a fixed large angle of aperture and a given thickness of the lens, it is easily seen what alterations a change in the refraction of the less refracting lens requires, according to the crown glass used, and we can correct the objective accordingly.

An objective, composed of three achromatics, whose curves were calculated for parallel rays (according to the formulæ and tables of the author) gave such satisfactory results that further detailed calculation is only required for exceptionally large angles of aperture.

The performance of a triplet of 8 mm. equivalent focus composed of three symmetrical endomersion lenses consisting of crown glass and a mixture of fatty and aromatic substances, gave perfect achromatism, for when achromatic eye-pieces (by Schröder) were used which magnified 9, 18, 36, and 72 times, there was even with the last, in bright lamplight and sunlight, scarcely a trace of colour on diatoms or on a Zeiss's silver grating, whilst all the objectives at hand * showed all the colours of the spectrum with such enormous eye-piece power.

With some of these objectives, however, the aplanatism was more perfect than others, which can probably be accounted for by slightly imperfect centering of the three lenses, and also by the defective quality of the plane-parallel plates, in place of which, later on, concave lenses of great focal length were used.

In direct light, with an angle of aperture of only 56°, all the more easy diatoms of Möller's plates were resolved, and of the more difficult the following:—*Rhabdonema arcuatum* and *R. adriaticum*, *Achnanthes subsessilis*, *Scoliopleura convexa* (the images appear black upon white).

With oblique light:—*Nitzschia circumsata*, *Navicula divergens*, *N. minor*, *Gomphonema geminatum*, *Melosira Borrerii*, *Symbolophora Trinitatis*, *Odontodiscus subtilis*, *Hyalodiscus stelliger*, and *H. subtilis* could not be quite resolved, as they were on the limits of the unresolvable with the aperture. *Grammatophora marina* and *Pleurosigma angulatum* were not resolved.

A double symmetrical endomersion objective, combined after the manner of Steinheil's "Symmetric Aplanaten," gave no trace of a difference of the chemical and visual foci, and therefore such an objective, which can be constructed from quartz and a very transparent fluid, is of practical importance for photography.

The usual contrivance is not necessary for obtaining sharp photographs of diatoms, which will even bear well a power of 30 times as

* Objectives by Schneider of Berlin, 1″ to $\frac{1}{9}$″ dry, and $\frac{1}{9}$–$\frac{1}{11}$ (*sic*) immersion, by Zeiss 1 *n* (A) and Hartnack, as well as Reichert of Vienna.

microscopic objects, furnishing the best proof of the coincidence of the optic and actinic foci. The eye-piece is removed and the camera placed in position, without having to make use in any way of coloured or subdued light for the illumination.

In an abstract* of Prof. Zenger's papers by G. Fischer, he expresses the apprehension that the unavoidable changes of temperature to which the lenses would necessarily be subject would be likely to impair their efficiency, and adheres to his own view that absolute achromatism will in all probability only be obtained by the discovery of more favourable kinds of glass.

Prof. Zenger subsequently wrote† to Herr Fischer that Merz's crown glass is still much wanting as regards refraction and dispersion; in his view crown and flint never give a rational dispersion, although flint containing different quantities of lead approximates to it. Incomparably better is the achromatism obtained by his fluid lenses, which are as much in advance of the best achromatics of the present time as these latter are in advance of the non-achromatics. The analogy of the eye, which formerly led to the discovery of partial achromatism, prompted him to try and obtain *absolute* achromatism by imitation of the gelatinous fluids of the eye, that is by mixing two, three, and four different fluids. In this he has succeeded; two or three fluids, oil and balsam mixed, give, compared with crown glass or quartz, quite rational spectra; that is constant ratio of the partial dispersions. A constant dispersion-quotient can be obtained for the whole length of the spectrum within 0·002 to 0·004, therefore much better achromatism than with the best of Merz's systems, in which the quotients differ from 0·004 to 0·026.

Finally he points out that the experiences of photography suffice to show how much the best productions of the first modern opticians fail in collecting all the rays to one focus. He, on the contrary, is able with his fluid system to obtain micro- and astrophotographs without the interposition of coloured glasses or adjustment-correction, just as if his lenses were mirrors; consequently, all rays, chemical and optical, are united in one focal point.

Prof. Safarik has pointed out‡ to Herr Fischer that whilst with Zenger's objectives perfect achromatism is undoubtedly almost attainable, yet it is very doubtful whether *aplanatism* (removal of spherical aberration) is also attainable. With Merz the diminution of the dispersion-relation necessarily entails a lengthening of the focus, the reverse of what opticians have hitherto striven to obtain. "Whether," adds Herr Fischer, "Zenger's system, the three-lens system (Merz's), the improved Herschel-Fraunhofer system with more perfect kinds of glass, Plössl-Littrow's, or an entirely new system, attains the desired end, this much may, I consider, be confidently expected, that sooner or later a considerable improvement of the achromatism, and with it of the optical capacity of the Microscope and telescope, will be assured. In conclusion, I gladly avail myself of the opportunity of bringing

* Central-Ztg. f. Optik u. Mech., iv. (1883) pp. 254–6.
† Ibid., p. 267.
‡ Ibid.

forward the opinion of so competent a judge as Dr. L. Dippel,* against that of Prof. Merkel, who has objected to Merz's object-glasses that they get dim from being too soft. Dr. Dippel writes: 'I have lately become more closely acquainted with Merz's objectives, 1/3, 1/9, 1/12, 1/18, and 1/24 in., and have convinced myself that the objection made to them by Prof. Merkel of their being affected by the air is not well founded.'"

Selection of a Series of Objectives.—At p. 449 (last line but one) a misprint occurs of 200° instead of 120° as in Dr. Carpenter's original text.

Correction-Adjustment for Homogeneous-Immersion Objectives.† —Dr. W. B. Carpenter's views on this somewhat vexed question are explained in his article "Microscope' in the 'Encyclopædia Britannica.'

After pointing out that with homogeneous-immersion objectives the microscopist can feel assured that he has such a view of his object as only the most perfect correction of an air-objective can afford, Dr. Carpenter continues as follows: "This is a matter of no small importance, for while in looking at a known object the practised microscopist can so adjust his air-objective to the thickness of its cover-glass as to bring out its best performance, he cannot be sure, in regard to an unknown object, what appearance it ought to present, and may be led by improper cover-correction to an erroneous conception of its structure.

"It has been recently argued that, as the slightest variation in the refractive index of either the immersion fluid or the cover-glass, a change of eye-pieces, or the least alteration in the length of the body—in a word, any circumstances differing in the slightest degree from those under which the objective was corrected—must affect the performance of homogeneous-immersion objectives of the highest class, they should still be made adjustable. The truth of this contention can, no doubt, be proved, not only theoretically, but practically, the introduction of the adjustment enabling an experienced manipulator to attain the highest degree of perfection in the exhibition of many mounted objects, which cannot be so well shown with objectives in fixed settings. But it may well be questioned whether it is likely to do the same service in the hands of an ordinary working histologist, and whether the scientific investigator will not find it preferable, when using these objectives, to accept what their maker has fixed as their point of best performance. The principal source of error in his employment of them lies in the thickness of the optical section of the object; for the rays proceeding from its deeper plane, having to pass through a medium intervening between that plane and the cover-glass, whose refractive and dispersive indices differ from those of the glass and immersion fluid, cannot be brought to so accurate a focus as those proceeding from the plane immediately beneath the cover-glass. The remedy for this, however, seems to be rather in

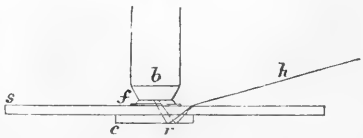
* 'Das Mikroskop,' 2nd ed., 1883, p. 460.

† Encyclopædia Britannica, 9th ed., xvi. (1883) p. 265.

making the preparation as thin as possible than in the introduction of what is likely, in any but the most skilful and experienced hands, to prove a new source of error. Every one who has examined muscular fibre, for example, under a dry objective of very high power and large aperture, well knows that so great an alteration is produced in its aspect by the slightest change in either the focal adjustment or the cover-correction that it is impossible to say with certainty what are the appearances which give the most correct optical expression of its structure. This being a matter of judgment on the part of each observer, it seems obvious that the nearest approach to a correct view will be probably given by the focal adjustment of the best homogeneous immersion-objectives, in fixed settings, to the plane of the preparation immediately beneath the cover-glass."

Lighton's Immersion Illuminator.*—This device of W. Lighton (fig. 101) consists of a small disk of silvered plate-glass *c*, about 1/8 in. thick, which is cemented by glycerin or some homogeneous-immersion medium to the under surface of the glass slide *s*, *r* being the silvered surface of the disk, *b* the immersion objective, and *f* the thin glass cover. The ray *h* from the mirror or condenser above the stage will enter the slide, and thence be refracted to the silvered surface of the illuminator *r*, whence it is reflected at a corresponding angle to the object in the focus of the objective. A shield to prevent unnecessary light from entering the objective can be made of any material at hand by taking a strip 1 in. long and 3/4 in. wide, and turning up one end. A hole of not more than 3/16 in. in diameter should be made at the angle. The shield should be placed on the upper surface of the slide so that the hole will cover the point where the light from the mirror enters the glass. "With this illuminator Möller's balsam test-plate is resolved with ease, with suitable objectives. Diatoms mounted dry are shown in a manner far surpassing that by the usual arrangement of mirror, particularly with large angle dry objectives."

FIG. 101.



Illumination by Daylight and Artificial Light—Paraboloids and Lieberkühns.†—E. M. Nelson finds daylight effective for low powers up to 2/3 in., and with condenser up to 1/6 in. Direct sunlight involves the use of a heliostat, otherwise the continued adjustment of the mirror is irksome. Where strong resolving power is needed, oblique pencils of sunlight from the heliostat outrival any other illumination; but much care is necessary not to injure the sight, and on the whole, he cannot recommend its general use except for photographing. Diffused daylight is too uncertain and too variable for accurate testing of objectives. It is not possible to get with diffused daylight the absolutely best image that an objective will produce.

* Amer. Mon. Micr. Journ., v. (1884) pp. 102-3 (1 fig.).
† Engl. Mech., xxxix. (1884) p. 48.

A really critical image could only be seen with artificial light, and with a good condenser and diaphragms. He does not mean to say that no good work can be done with diffused daylight, for excellent work is done with low or medium powers; but he insists that it is not possible to do any such critical work as testing objectives by daylight as thoroughly as it can be done by artificial light. With daylight and mirror only there is milkiness and "glaze." The milkiness can be got rid of by a diaphragm, and the "glaze" by using a ground glass behind the object. Unless a condenser is used there will always be found a falling off in the quality of the image with all powers higher than 2/3 in. From long experience in working with the Microscope, he feels justified in asserting that on the whole daylight is more trying to the sight than lamplight.

The oxy-hydrogen light may be serviceable for resolving such tests as Nobert's lines, but the incandescence lamp he regards as entirely a failure for microscopical purposes. "This is at once obvious upon the consideration that the finest images seen are got by viewing objects, as it were, *in the image of the source of light.* All critical images of transparent objects viewed by direct transmitted light require first that the source of light should be pictured by the condenser exactly in the plane of the object, the object then serves to interrupt the image of the source of light. The observer has simply to arrange the lamp, condenser, and diaphragms so as to produce the most perfect image of the source of light of the required size in the plane of the object, the objective will then have fair play. The size of the image of the lamp flame can be controlled by distancing the lamp. There is no other secret in the matter. With the incandescent lamp the image produced by the condenser represents the mere carbon thread, on which no object could be seen projected; in order to obtain some extent of brightly luminous field, the condenser must be put out of focus, then the intensity of the light is so reduced that the observer would simply discard the incandescence, finding it far less serviceable than a shilling paraffin lamp."

He entirely condemns the use of paraboloids for dark-ground illumination, as properly adjusted central stops with the condenser will give by far the best dark-ground illumination. For opaque objects he considers nothing has been devised so good as Lieberkühns, and objects ought as far as practicable to be mounted for use with Lieberkühns, and not covered up with paper. If the side illuminator is used it should be attached to a fixed part of the stand, not to the body-tube or stage.

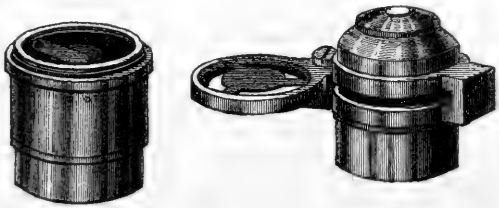
With the preceding remarks may be contrasted the view of Prof. Abbe (*in litt.*) that it is quite immaterial, from a theoretical point of view, whether an illuminator has or has not spherical aberration. The effect of illumination does not depend upon the projection of a *sharp image* of the source of light upon the object, nor even on the projection of any image at all. The only object of projecting an image of the source of light *approximately* at the plane of the object is in order that a uniform illumination of a given area

of the object (the field of vision) may be obtained by means of a small source of light. This object is attained notwithstanding considerable aberrations, and it is the better obtained the greater the focal length of the illuminating system. A lens of 3/4 in. curvature is therefore less advantageous than one of 1 in.

The general view of English microscopists is undoubtedly in favour of the superiority of an achromatic condenser over any non-achromatic arrangement. With the latter, confused pencils of light are produced by the spherical aberration, which seriously impair the images of fine structures, whilst with the former, "the most delicate objects are seen with a clearness and sharpness of detail quite unknown to those microscopists whose experience has been confined to the use of non-achromatic condensers." *

Bausch's New Condenser.†—E. Bausch describes a new condenser (figs. 102 and 103), similar to that of Prof. Abbe, the formula upon

Fig. 102. Fig. 103.



which it is constructed being, however, a modification of that used in Bausch's Immersion Illuminator. The posterior system is as large as the substage-ring will allow, and will transmit and condense all the rays which pass through this from the mirror. Its numerical aperture is about 1·42.

There are two styles of mounting, fig. 103 shows the substage adapter and condenser with a swinging diaphragm ring between them. This ring receives the various stops, which may be changed without disturbing the condenser. Fig. 102 is intended to give the different degrees of oblique illumination, from central to that of the utmost possible limit. It is provided with a circular opening, 1/4 in. in diameter, which may be decreased if desired, and which is caused to move slowly from the centre to the edge of the mounting by turning the outside milled edge.

Both of these mountings are adapted to substages attached either to the substage bar, or fixed to the bottom of the stage. The condenser is also furnished with plain substage adapter only.

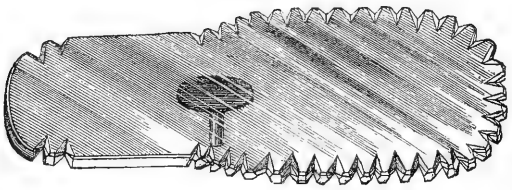
Glass Frog-plate.—This (fig. 104, designer unknown) is a simplification of the ordinary frog-plate. The general form of the

* Swift's 'The Microscope,' 1883, p. 43.

† The Microscope, iv. (1884) pp. 105-6 (2 figs.).

old brass plates is retained, but in place of brass glass is used, the edges of which are serrated for the string. The brass pin is at

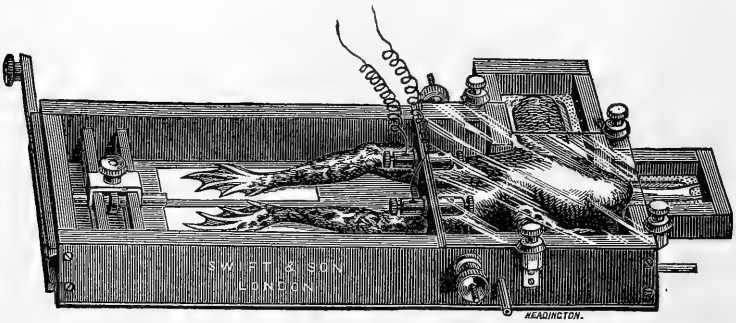
Fig. 104.



present only cemented to the plate; it would be better if it passed through it.

Groves and Cash's Frog-trough for Microscopical and Physiological Observations.—Some years since Mr. J. W. Groves devised a simple guttapercha trough, in which circulation in the webs of frogs could be observed for a considerable time without the web becoming dry. This was effected by keeping the feet of the frog entirely covered with water, into which the objective (protected by a watertight cap closed below by a piece of thin glass) could be lowered after the fashion of Mr. Stephenson's submersion objective. This contrivance he and Dr. Theodore Cash have considerably improved. The trough (fig. 105) is long enough to admit a full-sized frog; in

Fig. 105.



the bottom, which is lined with cork, are two windows of glass, through which light may be transmitted to the webs of the feet. At the anterior end is a projection, with a cork bottom and glass window for the examination of the tongue, and another similar projection at the side for the observation of the mesentery or lungs. The trough is made of vulcanite, and is watertight, but at the posterior end is a sliding piece by which that end can be opened and a thread passed through to the lever of a myograph. In convenient situations are binding screws for the connection of wires from a coil or battery.

Either or both of the projecting portions of the trough can be shut off from the main receptacle by sliding hatches (not shown in the fig.) if necessary, and the part containing the body of the frog can be covered with glass or a vulcanite lid. Should it be desired to observe the effect of gases or of heat or cold, the required gases or warm or cool air may be conducted through the body chamber by means of the two small tubes seen projecting from the front and sides respectively.

The frog to be observed is placed either ventrally or dorsally as may be required, and is held by means of loops of thread passed round the arms and then led through screw-eyes and clamped up. The thighs are held by a pair of stocks, which, by means of a sliding upper half, can be adjusted accurately to the limbs without causing constriction; and the webs are spread out by pinning loops of thread tied to the toes.

Visibility of Ruled Lines.*—C. Fasoldt writes, in regard to the note by Professor W. A. Rogers, which appears at p. 439 of vol. iii. (1883), that "there are some statements which do not agree with my experience. I find that lines properly ruled on glass are similar to graven lines; they are smooth, clean cut, having a definite shape and depth. Such lines are always visible in the Microscope, and central or oblique light will show the bottom of each cut as a dark or coloured line, plainly visible, and requiring no graphite or other foreign substance to indicate it. The Microscope is the test for a properly ruled line. The mechanical elements (pressure, &c.) entering into the process of ruling are not at all evidences that lines have been properly ruled. The slightest accident to the point of the cutter, or the surface of the glass not being perfectly clean, will spoil a line; that is, produce a scratch which cannot be satisfactorily illuminated in any light. Well-ruled bands of lines, 70,000 or 80,000 to the inch, are visible in the Microscope with central light; and with a Smith vertical illuminator (giving central light), I have seen 100,000 lines to the inch. As these individual lines have a width of about 1/200,000 of an inch only, it follows that the difficulty is not to see such a narrow line, but to eliminate the diffractions which tend to blur the image in the Microscope, and so prevent the resolution or separation of the lines in a band of them."

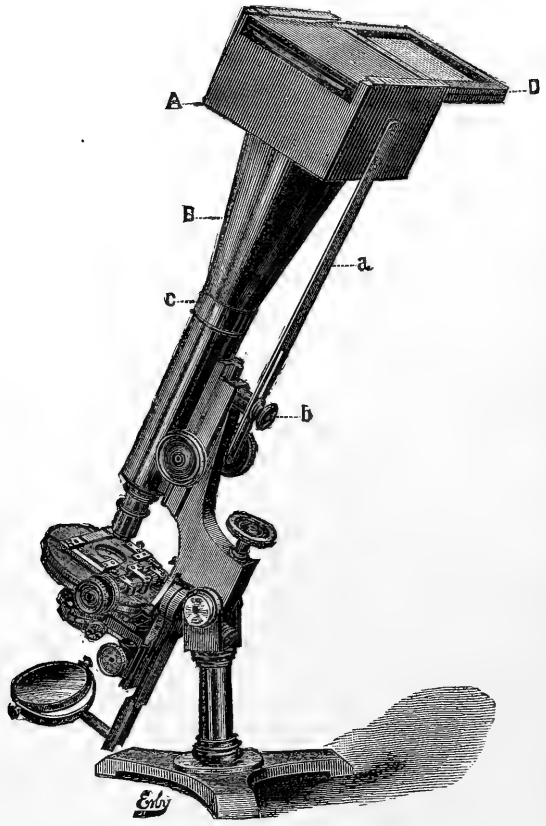
Mercer's Photomicrographic Camera.†—Dr. F. W. Mercer has devised the camera shown in fig. 106. It consists of a box of light wood A, a cone of light metal B, a tube which takes the place of the ordinary draw-tube of the Microscope, C, and the frame carrying the ground glass and plate-holder, D. The tube C is fitted to the cone B, so that it may be withdrawn for the insertion of an eye-piece or amplifier. To the box A is attached a brass strap *a*, the lower end being slotted to admit the passage of a binding screw secured to a button *b*, fastened to the arm of the stand. As soon as the object is coarsely focused upon the ground glass the cone and its tube are

* Scientific American, xlviii. (1883) p. 341.

† 'Photography' (Chicago), i. (1884) pp. 9–10 (1 fig.).

raised slightly, say about a quarter of an inch from the body of the Microscope, and the binding screw is then tightened, securing the weight of the camera, &c., upon the arm of the instrument, thus removing any undue pressure upon the rack and pinion, or fine movement of the tube, during future manipulation. The fine focusing

FIG. 106.



when completed leaves nothing to be done but to push the ground-glass frame on till it is replaced by the plate-holder, when the picture may be made.

The features claimed for this apparatus are: "Its great portability, measuring when the draw-tube has been removed from the cone, $4\frac{1}{4} \times 4\frac{1}{4} \times 9$ in.; its ready application to the Microscope in any position from the vertical to the horizontal, requiring but a few minutes for its adjustment without changing the position or light, at least for moderate powers; its special fitness for the amateur, being

moderate in first cost and inexpensive in use from the size of the plate used. Though the plate is small, $3\frac{1}{4} \times 4$ in. (lantern size), it is very useful and will meet most of the needs of the amateur workers for whose convenience the instrument is intended.

There is a class of work of which this little camera is incapable, and in introducing it to the notice of microscopists, it is not intended to convey the impression that it will supersede other means where skilled hands and elaborate apparatus are absolutely necessary. To those who have but an hour or two of an evening for observation with the Microscope, this camera may prove of service in securing a photograph quickly at the work-table.

The box above the cone might be dispensed with, and the slide carrying the ground glass attached directly to the large end of the cone. The advantage in having the box is the shutter, which may be fitted to its interior for excluding light from the plate at the moment of completing the exposure, a preferable means to that of placing a piece of black paper between the objective and the source of light. Instead of having the ground glass and plate-carrier in one frame, it might be desirable for some to have them separate, having more than one plate-holder. The apparatus can at a trifling cost be attached to most stands, and when properly made should not exceed, including ground glass and plate-holder, seven or eight ounces in weight."

Photographing Bacillus tuberculosis.*—M. Defrenne describes the process which he adopts to photograph this *Bacillus* with a Tolles' 1/10 in. (hom. imm.), without eye-piece, using extra rapid bromo-gelatine plates, developed with ferro-oxalate, a petroleum lamp being employed for illumination.

If, he says, the determination of the actinic focus of objectives constitutes, so to say, the chief difficulty in photographing ordinary microscopic preparations, it is no longer so when we deal with organisms so infinitesimally small as the bacilli of tuberculosis. Here arises a difficulty of quite another kind, which at first seemed insurmountable: the staining of the bacilli by means of fuchsin. This agent, even when it is employed in thick layers, is somewhat actinic, and it becomes the more so as the object stained is smaller or more transparent. These two circumstances are combined in the highest degree in the organisms in question. Thus at the beginning the plates exposed were either uniformly acted on or the image was so faint and so little differentiated after development that they were worthless for proofs on glass or on paper.

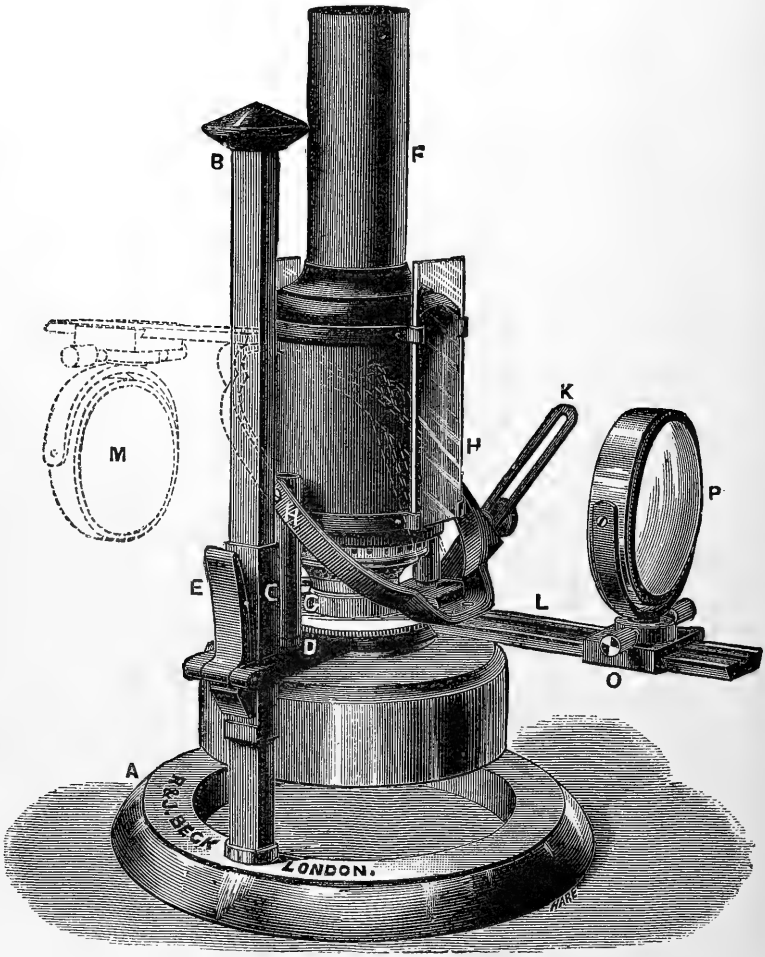
These negative results suggested the abandonment of the attempt, when the idea was suggested of having recourse to the use of a *compensating glass* of a colour complementary to red (that is green), placed between the objective and the sensitized plate. By thus filtering the image formed by the objective, the red rays, the only ones passing through the bacilli, are absorbed, if not wholly, at least in great part. The microbes therefore appear nearly black on the plate, and make

* Bull. Soc. Belg. Micr., x. (1884) pp. 128–32.

a much slower impression than the rest of the preparation, which gives free passage to all the green rays. More contrast is thus obtained and a very distinct photograph produced.

Beck's "Complete" Lamp.—For pathological and physiological investigation, as also for many other branches of microscopical

FIG. 107.



research, a lamp more delicate in its adjustments and giving a greater control over the light than those ordinarily in use is requisite, and Messrs. Beck have therefore constructed a lamp whereby more

perfect illumination of both opaque and transparent objects can be obtained.

The base A (fig. 107) consists of a heavy ring, into which a square brass rod B is screwed. The square rod carries a socket C with an arm D, to which the lamp is attached. This socket fits the square rod loosely, but is kept in any position by a lever E, which is pressed firmly against the square rod by a strong spring. If the lever and the opposite side of the socket are taken between the thumb and finger, the pressure of the lever on the bar is removed, and the lamp can be raised or lowered to the desired position, when by releasing the hold the lamp is at once clamped.

On each side of the burner, and attached to the arm D, is an upright rod G, to one of which the chimney is fixed, independent of the reservoir of the lamp, but fitting closely over the burner, thus enabling the observer to revolve the burner and reservoir, and obtain either a thin intense light or a broad and diffused one, without altering the position of the chimney. The chimney F is made of thin brass, with two openings opposite to each other, into which slide 3×1 glass slips of either white, blue, or opal glass, the latter serving as a reflector.

The reservoir, although holding enough oil to burn for several hours, is made very flat, and drops into the annular base, thereby bringing the flame of the lamp within 3 inches of the table, rendering it much more serviceable for direct illumination (without the mirror) and for other purposes.

A semicircle swings from the two uprights G, to which it is attached by the pins H, placed level with the middle of the flame; to this semicircle is fixed a dovetailed bar L, carrying a sliding fitting O, which bears a Herschel condenser P.

This condenser, swinging with the middle of the flame as a centre, is always at the same distance from it; and thus, when once focused, needs no further alteration for any change in the inclination of the beam of light. The condenser is fixed at any inclination by a milled head working in a slotted piece of brass K, fixed to the arm D.

When used for transparent illumination, the condenser is not required below the horizontal position; but when the lamp is required for the illumination of opaque objects, the chimney having been temporarily removed and the milled head fixing the condenser arm having been loosened, the arm with the condenser can be thrown over the lamp, as shown in the illustration at M, and the chimney being replaced, the light, which now comes through the opposite opening of the chimney, can be condensed at a large angle below the horizontal.

James' 'Aids to Practical Physiology.'*—It is beyond our comprehension how this extraordinary book could ever have been written by an author entitled to add M.R.C.S. to his name, or published as a volume of 'Students' Aids Series' by such publishers as those whose

* J. Brindley James, M.R.C.S., 'Aids to Practical Physiology,' 8vo, London (Baillière, Tindall, & Cox), 1884, viii. and 60 pp.

names are attached to the title-page, which moreover bears the motto "Mens sana in corpore sano." That we do not criticize it without reason will be seen by the following extract which is prefaced by the statement that it contains a "few practical hints which we trust may "powerfully tend to facilitate the young experimentalist's labours." (The italics are ours.)

"The Microscrope (sic).—You cannot expect to get one of any valuable power (!) under five guineas. It should be of two powers, enabling you to use inch and quarter-inch glasses (!) The hole in the stage should have its *axis diametrically consistent (!) with that of the tube* of the instrument. *A stand is also needed* (!!) Object-glasses, denoted as one-fourth, one-fifth, one-sixth, are used for high powers, *one-half to two-fifths* (!) for low. An oil-immersion lens is now-a-days a necessary complement, and should be about one-twelfth. The simpler it is the better for a beginner (!) The same may be said of the eye-piece (!!) With respect to such other adjuncts as achromatic condensers, special stands, &c., these concern the accomplished microscopist rather than the tyro."

As it was obvious that the author was not at home in the optical branch of his subject, we turned to the description of a piece of apparatus with which the practical physiologist should necessarily be intimately acquainted—the Microtome. Will it be believed that it is described not as an instrument for cutting sections, but for freezing specimens! The author's own words are as follows: "The Micro-"tome. This useful device for freezing specimens is susceptible of "various forms of construction."

After these extracts it is superfluous to refer to the other minor blunders which disfigure the book, such as the description of Dr. Klein as "Kleän," the indiscriminate use of "bichromate of potash," "potass" and "potassium," and "potassic bichromate" for the same substance.

Postal Microscopical Society.—This society is now forming a section specially devoted to members of the medical profession (including students).

"A President."—Suggestion for making the 'Journal of Microscopy' the Journal of provincial and other Microscopical Societies.
Journ. of Micr., III. (1884) pp. 194–5.

"Amateur."—Bacteria and the Microscope.
[Elementary Inquiries.] *Engl. Mech.*, XXXIX. (1884) pp. 465–6.

American Society of Microscopists, Session of 1884.—Circulars of President J. D. Cox, and E. H. Griffith. *Micr. Bull.*, I. (1884) pp. 25 and 28.
Amer. Mon. Micr. Journ., V. (1884) pp. 117–8.
The Microscope, IV. (1884) p. 133.

Belfield, W. T.—Photo-micrography in Legal Cases. [*Post.*]
Photography (Chicago), I. (1884) pp. 54–9 (7 figs.).

Bradbury, W.—Papers relative to the theory of the Object-glass.
[Note introducing paper by Dr. C. S. Hastings, from 'Amer. Journ. Sci.,' detailing the method used by him to determine the optical properties of various kinds of glass and the alterations in the properties when the glass was subjected to different temperatures.]
Engl. Mech., XXXIX. (1884) pp. 420–1.

BULLOCH, W. H.—The Congress Nose-piece.
[Further rejoinder to Prof. McCalla's claim of priority.]
Amer. Mon. Micr. Journ., V. (1884) pp. 119–20.

CARNOY, J. B.—La Biologie Cellulaire. Etude comparée de la cellule dans les deux Règnes. (Cellular Biology; a comparative study of the cell in the two kingdoms.) Fasc. I. 271 pp. and 141 figs. 8vo, Lierre, 1884.
[Part I. Microscopical Technics (pp. 37–167, 24 figs.). 1. On instruments and the laboratory of the microscopist or cytologist. 2. On objects and their preparation. 3. On the method to be followed in microscopical observations and cytological researches.]

CARPENTER, W. B.—Article "Microscope" in the 'Encyclopædia Britannica,' 9th ed., XVI. 4to, Edinburgh, 1883. [*Cf. ante*, pp. 448 and 620.]

COX, J. D.—See American.

" " Photographs showing the structure of Diatom shells.
Amer. Mon. Micr. Journ., V. (1884) p. 112.

D., E. T.—Graphic Microscopy. VI. Pupa of Locust, one day old. VII. Cluster Cups: *Æcidium quadrifidum*.
Sci.-Gossip, 1884, pp. 121–2 (1 pl.), 145–6 (1 pl.).

DEFRENNE.—Présentation d'une Microphotographie du *Bacillus tuberculosis*. (Exhibition of a photomicrograph of *Bacillus tuberculosis*.) With remarks by E. van Ermengem. [*Supra*, p. 627.]
Bull. Soc. Belg. Micr., X. (1884) pp. 128–32.

DUDLEY, Prof.—Microscopic Photography:
[Response to a toast.] *Photography* (Chicago), I. (1884) pp. 71–2.

ERMENGEM, E.—See Defrenne.

F.R.A.S.—Optical Recreations.
[Containing a note on the convex lens used as a magnifying glass.]
Knowledge, VI. (1884) pp. 46–7 (4 figs.).

FRANCOTTE, P.—Aspirateurs pour tenir constamment saturée d'air l'eau des récipients où l'on observe les animaux et les plantes aquatiques. (Aspirators for keeping saturated with air the water of receptacles for observing aquatic animals and plants.) [*Post.*] *Bull. Soc. Belg. Micr.*, X. (1884) pp. 141–3.

Giant Electric Microscope.
[Criticism of its defects.] *Journ. of Sci.*, VI. (1884) p. 370.

GILL, D.—Article "Micrometer" in 'Encyclopædia Britannica,' 9th ed., XVI., p. 248. 4to, Edinburgh, 1883.
[Contains "How to web a filar micrometer." *Post.*]

GOWEN, F. H.—Resolution of *Amphipleura*.
[Direct sunlight above the stage. "The Microscope should be so placed that the light may fall on the circumference of the stratum of immersion fluid obliquely to the upper surface of the slide, and care should be taken to have one end of the frustule point towards the sun."]
Amer. Mon. Micr. Journ., V. (1884) p. 118.

" " Resolution by Central Light.
[Resolution of *A. pellucida* in balsam by sunlight with the mirror in a strictly central position. "The resolution was effected by light reflected within the slide from one of its convex edges, and that instead of being central the light was very oblique."]
Amer. Mon. Micr. Journ., V. (1884) pp. 118–9.

GRIFFITH, E. H.—See American.

HARDY, J. D.—Microscopical drawing.
[Report of demonstration.] *Journ. Quek. Micr. Club*, I. (1884) pp. 360–1.

HASTINGS, C. S.—See Bradbury, W.

HAZLEWOOD, F. T.—A home-made revolving table.
["I got a second-hand sewing-machine table . . . Then I took another table-top which was raised about 2 in. from the other by a moulding. On the top of the first table I put a piece of pine board 1 in. thick. Into this I put three small castors upside down. I bored three holes in the top of the other table, on radii, from a common centre. Then I put top No. 2 over top No. 1, so that the castors came over the surface about 1/4 in.

Through the centre of both tables I bored another hole. Then I took a steel saw-plate into which the teeth had not been cut. I had a hole bored in its centre, and two brass handles or pins put in opposite each other near the circumference. This plate is fastened by a pin with nuts on the table over the three castors. The table is perfect. I painted the steel plate. The drawer of the first table on the side serves for accessories. The whole thing cost less than five dollars. The finished table looks as though made for this purpose, and not for a sewing-machine."]

Amer. Mon. Micr. Journ., V. (1884) p. 94.

HERRICK, S. B.—The Wonders of Plant Life under the Microscope. 248 pp. and 85 figs. 8vo, London, 1884.

HERTWIG, O. — Die Verwendung des Sciopticons als eines Anatomischen Unterrichtsmittels. (The employment of the Sciopticon for anatomical instruction.)

[Exhibition of glass photograms and sections.]

SB. Jenaisch. Gesell. Med. & Naturwiss., 1883, p. 17.

HEURCK, H. VAN—[Protest against the review of his "Lumière électrique," by Stein, in 'Zeitschr. f. Wiss. Mikr.']

Journ. de Microgr., VIII. (1884) pp. 273–7.

HITCHCOCK, R.—The Postal Microscopical Club.

[Exhortation to put better slides in the boxes.]

Amer. Mon. Micr. Journ., V. (1884) pp. 113–4.

JAMES, F. L.—The St. Louis Microscopical Society.

[Notification of its formation.] *The Microscope*, IV. (1884) pp. 129–30.

JAMES, J. B.—Aids to Practical Physiology. viii. and 60 pp. 8vo, London, 1884. [*Supra*, p. 629.]

LIGHTON, W.—Immersion Illuminator. [*Supra*, p. 621.]

Amer. Mon. Micr. Journ., V. (1884) pp. 102–3 (1 fig.).

MÖBIUS, K.—Rathschläge für den Bau und die innere Einrichtung zoologischer Museen. (Advice on the construction and internal arrangement of Zoological Museums.)

[Contains a reference to the "Microscopirzimmer."]

Zool. Anzeig., VII. (1884) pp. 378–83.

MÜLLER, P.—Insectenfänger mit Lupe. (Insect-catcher with lens. *Post.*)

German Patent No. 25,806, 6th June, 1883. See *Zeitschr. f. Instrumentenk.*, IV. (1884) pp. 259 (1 fig.).

NELSON, E. M.—How to Work with the Microscope.

[Report of demonstration. See *ante*, pp. 447 and 464. The view originally expressed as to the decided preference to be given to the Ross form over the Jackson is modified. "In point of steadiness he did not think there was much to choose between them in first-class stands."]

Journ. Quek. Micr. Club, I. (1884) pp. 375–9.

" " The Health Exhibition.

[Description of Microscopes, Apparatus, &c., exhibited.]

Engl. Mech., XXXIX. (1884) pp. 437–9.

ROGERS, W. A.—On a practical solution of the perfect screw problem.

[Describes the method by which it is claimed a perfect screw can be made on a common lathe, including a Microscope provided with Tolles' opaque illuminator attached to the carriage moved by the leading screw of the lathe.]

Engl. Mech., XXXIX. (1884) pp. 341–2.

Royal Microscopical Society: Notes as to the admission of ladies and rearrangement of the Cabinet. *Journ. of Sci.*, VI. (1884) p. 437.

SCHNEIDER, E.—Ueber eine Justirvorrichtung an einem Krystallgoniometer. (On an adjusting arrangement for a Crystal Goniometer.)

[Differential screw.]

Zeitschr. f. Instrumentenk., IV. (1884) pp. 242–4 (1 fig.).

Stein, S. T.—Das Mikroskop und die mikrographische Technik zum Zwecke photographischer Darstellung. (The Microscope and Microscopical Technic in Photographic representation.) Part II. of 'Das Licht im Dienste wissenschaftlicher Forschung,' 2nd ed., pp. i.–ix. and 151–322, figs. 168–302, pls. iii–vi. 8vo, Halle a. S., 1884.

Stowell, C. H.—Rochester meeting [of American Society of Microscopists]. *The Microscope*, IV. (1884) pp. 131–2.

Strasburger, E.—Das botanische Practicum. Anleitung zum Selbststudium der mikroskopischen Botanik für Anfänger und Fortgeschrittnen. (Practical Botany. Guide to the study of microscopical Botany for beginners and advanced students.) xxxvi. and 664 pp., and 182 figs. 8vo, Jena, 1884.

Talbot, R.—Das Scioptikon, Vervollkommneter Projectionsapparat für den Unterricht. 7th ed., vi. and 82 pp. 8vo, Berlin, 1884.
[Mainly a Catalogue of Photograms and microscopical preparations.]

Thurston, E.—The Microscope: its Construction and Manipulation. *Micr. News*, IV. (1884) pp. 150–2.

Waters, W. H.—Histological Notes for the use of Medical Students. vi. and 65 pp. 8vo, Manchester and London, 1884.
[The body-tube of the Microscope is (not aptly) styled the "telescope-tube"! and the concave mirror the "curved mirror."]

Wenham Button.
[To keep the Wenham button or the common hemispherical lens in position while examining temporary mounts, fix it with glycerin or immersion fluid to that surface of a slide on which has been turned a wax or an asphalt ring, the internal diameter of which corresponds to the diameter of the lens. Invert the slide, and it is ready for use.]
The Microscope, IV. (1884) p. 134.

β. Collecting, Mounting and Examining Objects, &c.

Methods of Investigating Animal Cells.*—Dr. A. Brass has devoted several years of close study to the structure and life of animal cells, and gives a detailed account of his methods. The following are some of the more important of these methods:—

1. *Protozoa.*—As most Protozoa move very rapidly when hungry, it is well to feed them before attempting to study them with the Microscope. If well fed with powdered pieces of plants, &c., they usually remain quiet after a short time, and begin to assimilate the food-material which they have appropriated. In this condition of comparative quiet they can be easily examined with high powers. For this purpose they may be placed under a cover-glass with a considerable quantity of water and a number of small green algæ to keep the water supplied with oxygen.

For higher powers Abbe's illuminating apparatus is extremely useful. In some cases it is desirable to have a completely one-sided illumination, and this is best effected by inserting beneath the illuminating apparatus a circular diaphragm-plate perforated with a slit 3 mm. wide that runs parallel to the edge of the plate. It is best to leave about 2 mm. between the slit and the edge of the

* Zeitschr. f. Wiss. Mikr., i. (1884) pp. 39–51. Cf. Amer. Natural., xviii. (1884) pp. 650–1.

plate. Several diaphragm-plates should be prepared in which the slit varies in extent from a half to a whole of a quadrant or more.

The following mixture, which is Meckel's fluid with the addition of a little acetic acid, is recommended above all other reagents as a preservative medium:

Chromic acid	1 part.
Platinum chloride	1 „
Acetic acid	1 „
Water	400–1000 parts.

Unicellular animals die very slowly in this mixture, and suffer very much less alteration in structure than when killed in osmic acid or picro-sulphuric acid.

A special method is required for Protozoa filled with opaque food-material. In many cases the nucleus and the structure of the cell-body are completely obscured by foreign bodies. The method adopted in such cases is as follows:—

(1) Placed in picro-sulphuric acid 3–4 minutes.

(2) Transferred to boiling hot water for a short time.

(3) Placed in water and a little ammonia added; this causes the contracted object to swell up to its original size and form.

(4) Neutralize the ammonia with a little acetic acid, and then

(5) Colour with borax-carmine or ammonia-carmine.

(6) Wash and examine in dilute glycerin.

The picro-sulphuric acid destroys the nutritive material; the ammonia dissolves any particles of fat that may be present; and thus the object becomes transparent as far as possible.

A concentrated solution of corrosive sublimate may also be used with success for killing Protozoa; but care must be taken to wash thoroughly.

Dr. Brass has obtained his best results without reagents or dyes.

Born's Method of Reconstructing Objects from Microscopic Sections.*—Dr. G. Born describes in detail a very ingenious method of constructing models of objects from serial sections. By the aid of the camera the outlines of the sections are transferred to wax plates, which are then cut out so as to correspond in outlines as well as dimensions to the sections equally magnified in all three directions. With plates thus prepared, it is only necessary to put them together in the proper order to obtain a complete model. The method is simple and extremely useful, especially in investigating objects with complex internal cavities. Born has made use of the method in studying different parts of the vertebrate head; Swirski, in elucidating the development of the shoulder-girdle of the pike; Stöhr, in tracing the development of the skull of Amphibia and Teleostei; and Uskow, in studying the development of the body-cavity, the diaphragm, &c.

* Arch. f. Mikr. Anat., xxii. (1883) pp. 584–99. Cf. Science, ii. (1883) p. 802, and Amer. Natural., xviii. (1884) pp. 446–8.

Born makes use of three rectangular tin boxes of equal sizes, each measuring 270 mm. × 230 mm. × 2½ mm. Sections should be made about 1/25 mm. thick (never thinner than 1/50 mm.). If we desire to construct a model of an object from serial sections 1/30 mm. thick, which shall be magnified 60 diameters, then the wax plates must be made 60 times as thick as the sections, i. e. 2 mm. thick.

The surface of a plate that could be made in a box of the above-named dimensions, contains 62,100 sq. mm.; and the volume of such a plate 2 mm. thick would therefore be 124·2 c.cm. The specific gravity of common raw beeswax amounts to ·96–·97. For use, it requires only to be melted and a little turpentine added to make it more flexible. Thus prepared, its specific gravity is about ·95; and this number has been found sufficiently accurate in all cases. The weight of the wax required to make one plate of the above size, will accordingly be 117·99 gr., or, in round numbers, 118 gr. The wax having been weighed and melted, the tin box is first filled 1½ cm. deep with boiling water, and then the melted wax poured upon the water. If the water and the wax are quite hot, the wax will generally spread evenly over the surface; if gaps remain, they can be filled out by the aid of a glass slide drawn over the wax. As soon as the plate has stiffened, and while it is still soft, it is well to cut it free from the walls of the tin box, as further cooling of the water and the box might cause it to split. By the time the water becomes tepid, the plate can be removed from the water to some flat support, and left till completely stiffened. Half a hundred plates may thus be prepared in the course of a few hours.

The outlines of the section are transferred to the plate in the following manner: a piece of blue paper is placed on the plate with the blue side turned towards the wax, and above this is placed a sheet of ordinary drawing paper. The outlines are drawn on the latter by the aid of a camera, and at the same time blue outlines are traced on the wax plate. The plate can then be laid on soft wood and cut out by the aid of a small knife. Thus a drawing and a model of each section are prepared. The plates thus prepared can be put together in the proper order, and fastened by the aid of a hot spatula applied to the edges.

Shrinking Back of Legs of Oribatidæ in Mounting.*—A. D. Michael suggests a mode of getting over the difficulty of the shrinking back, during the process of mounting, of the legs of species of *Oribata* and other genera which have special cavities for the reception of the legs. The process requires careful manipulation, but if well done is very successful. Place a very thin layer of balsam upon the slide upon which the specimen is to be soaked in oil of cloves; when this layer becomes sticky the specimen is placed upon it, dorsal surface downwards. The mounter must then extend the legs and stick them to the balsam, if they rise up they should be pressed down again with a hair; when they are all fast the body should be brushed over with the smallest possible quantity of oil of cloves to prevent its drying,

* 'British Oribatidæ' (Ray Society) 1884, pp. 104–5.

but without touching the legs. This brushing with oil of cloves must be repeated from time to time as it sinks into the body. When a creature is ready, which can only be learned by experience, a large drop of oil of cloves, not benzole, may be put on; when this has *thoroughly* dissolved the balsam, but not before, the specimen may be moved and mounted, or further soaked in oil of cloves.

Preparing the Liver of the Crustacea.*—For the study of fresh tissues J. Frenzel places a small piece of the organ on the slide, *in the blood of the individual from which it was taken;* or, *in sea-water diluted until the salt contained amounts to about* $1\frac{1}{2}$–2 *per cent.* (one part distilled water and one part sea-water from the Bay of Naples). The so-called "physiological salt-solution" (3/4 per cent.) worked unfavourably, causing maceration.

Various fluids were employed for killing and hardening, partly for determining the effect of different reagents on the nuclei and the protoplasm, and partly for finding the best means of preparing the object for sectioning.

Very good preparations were obtained with *warm* alcohol from 70–90 per cent.; while direct immersion in absolute alcohol did not prove advantageous. This treatment gave good results for the cell-protoplasm, but destroyed the structure of the nuclei. Still better results were obtained for the cells (not for the nuclei) by adding a few drops of iodine to 70 per cent. alcohol.

The most satisfactory results were reached by immersing the object in a saturated aqueous solution of corrosive sublimate from ten to thirty minutes, then washing with water, and finally replacing the water gradually with alcohol.

Perenyi's fluid gave best results when combined with corrosive sublimate. The object was left from five to ten minutes in the first-named fluid, then transferred to the second and left for the same time.

While these methods were good for the Decapods, Amphipods, and Phronimidæ, the Isopods required a different treatment. With these, Kleinenberg's picro-sulphuric acid, diluted with an equal volume of water, and allowed to act 15–20 minutes, gave much better preparations than the sublimate solution.

Preparing Alcyonaria.†—In studying the mesenterial filaments of the Alcyonaria, E. B. Wilson obtained the best results in the following manner.

The animals were suddenly killed by momentary immersion in a mixture of 1 part strong acetic acid and 2 parts of a concentrated solution of corrosive sublimate in fresh water. After being quickly washed, they were transferred to a concentrated solution of sublimate in fresh water and left two or three hours; the internal cavities being injected with the solution, where this was possible. They were then thoroughly washed in running sea-water, then in distilled

* MT. Zool. Stat. Neapel, v. (1884) p. 51. Amer. Natural., xviii. (1884) pp. 556–7.

† MT. Zool. Stat. Neapel, v. (1884) p. 3.

water, and finally preserved in successive grades of alcohol. A weak solution of iodine in alcohol and sea-water also gives beautiful results, but is less certain in its action. For staining he used Grenacher's alum-carmine, borax-carmine, picro-carmine, and Kleinenberg's hæmatoxylin. Much the best results are obtained by the use of alum-carmine, but it must be used as quickly as possible, since the gelatinous tissue of the mesoderm is apt to shrink if the object be left too long in aqueous fluid. The tissues were decalcified with very weak nitric or hydrochloric acid in 90 per cent. alcohol. For maceration, the Hertwigs' well-known mixture of osmic and acetic acid gives good results.

Semper's Method of making Dried Preparations.*—B. Sharp redescribes this process.†

After hardening in chromic acid solution ($\frac{1}{4}$–1 per cent.) and being repeatedly washed, the object is placed in alcohol, 30–40, 60–70, and 90–95 per cent. successively, and finally in absolute alcohol.

This stage of absolute alcohol is the most critical part of the whole process. *Absolutely* every particle of the water must be removed, and the secret of the whole process depends on this one point. If any water be left in the tissue, it will become spotted and eventually spoil. After all the water has been withdrawn by the absolute alcohol, by remaining in it for three days to a week, the object is placed in turpentine, the best that can be procured. In this it is allowed to remain until it becomes thoroughly saturated: with large objects it is best to change the turpentine once. Two or three days are required for this stage. When saturated, the object is quite stiff, and when the process is successful little or no contraction has taken place. The object is then placed in the air and protected carefully from the dust, and the turpentine allowed to evaporate. The object then soon presents a very beautiful appearance; it becomes white, resembling the whitest kid. It is light, stiff, and, on account of the resin it contains, is perfectly insect-proof. In annelids the iridescence is perfectly kept; hair and feather retain their original colours.

Method of Detecting the Continuity of Protoplasm in Vegetable Structures.‡—W. Gardiner makes the following observations on the various methods for observing the protoplasmic threads which pass from cell to cell.

During the earlier part of his work he used sulphuric acid in combination with Hoffmann's violet. This latter reagent, at the time of staining, colours equally protoplasm and cell-wall. If, however, the section be treated for some time with dilute glycerin, the staining of the cell-wall is removed, and the protoplasm alone remains clearly stained. A very useful reagent for the demonstration of sieve-tubes may be made by dissolving Hoffmann's violet in strong sulphuric acid. After treatment with this solution the sieve-tubes are well brought into view, and all lignified tissue assumes the usual

* Proc. Acad. Nat. Sci. Philad., 1884, pp. 24–7.
† See this Journal, i. (1881) p. 706.
‡ Arbeit. Bot. Inst. Würzburg, iii. (1884) pp. 53–60 (English).

gold-yellow tint, as after treatment with aniline chloride and hydrochloric acid.

In working with sulphuric acid the fresh material is first cut in water. A section having been taken up with a platinum spatula, and the excess of water removed by blotting-paper, a drop of strong sulphuric acid is placed upon it, and allowed to act for a short time, usually a few seconds. The section is then plunged into water and rapidly washed. After several washings it may be stained and mounted. As a staining reagent, either Hoffmann's violet or preferably Hoffmann's blue may be used. In the former case the section is quickly stained, washed in water, and then placed for twenty-four hours or more in dilute glycerin, which dissolves out a great portion of the dye from the stained cell-wall, and at the same time removes the peculiar staining of the pits, which, if allowed to remain, is apt to lead to very delusive results. The section is finally mounted in glycerin. When Hoffmann's blue is used, a moderate quantity of the dye is dissolved in a 50 per cent. solution of alcohol to which have been added a few drops of acetic acid. After staining, the sections are washed with water and mounted in glycerin. Or a sufficient quantity of the dye may be dissolved in a 50 per cent. solution of alcohol which has been saturated with picric acid, until the solution assumes a dark greenish-blue tint. To this solution Gardiner gives the name picric-Hoffmann's-blue. After staining, the sections are washed with water and mounted in glycerin as before; or, after treatment with alcohol, they may be cleared with oil of cloves and mounted in Canada balsam.

In Tangl's method, sections of endosperm were stained with iodine and mounted in chlor-zinc-iod. In such dry tissue as ripe endosperm cells the cell-walls do not turn blue, but merely remain stained with the ordinary yellow-brown due to iodine. The protoplasm, on the other hand, assumes a very dark brown coloration, and after some time there comes into view a series of striæ traversing the thickened cell-wall, which, from their coloration, and from the fact that their depth of staining varies *pari passu* with that of the protoplasm, are taken to be essentially protoplasmic in character. Although in cases where it can be applied this method is of great value, it is attended also with some disadvantages. Firstly, in tissues containing a higher percentage of water the walls assume the ordinary cellulose blue, which at once prevents the threads from being seen; and, secondly, on account of the extensive and varied staining properties of the iodine, the results obtained by it alone cannot be taken as entirely conclusive. But, where practicable, Tangl's method is of great use in giving at least an idea of the existence of the protoplasmic threads, and the staining of the threads with iodine is much more distinct than with any other reagent.

To obviate these difficulties Gardiner adopted the modification already described of dissolving Hoffmann's blue in a 50 per cent. solution of alcohol saturated with picric acid; and, on washing out, the threads were found to be well stained, the picric acid bodily carrying, as it were, the solution of the dye into the fine protoplasmic

strands. Picric acid has also another valuable property in tending to prevent the staining of cellulose by dyes which, although possessing an especial affinity for protoplasm, will stain the cell-wall also unless some such restraining reagent be used. The sections are first stained with iodine and mounted in chlor-zinc-iod. If the material is favourable, something may then be seen of the threads. After being exposed to the action of the chlor-zinc-iod for about 12 hours, the sections are well washed, stained with picric-Hoffmann's-blue, washed again in water, and finally mounted in glycerin, or, better still, placed in alcohol, first dilute and at length absolute, cleared with oil of cloves, and mounted in Canada balsam. In those cases where the tissue swells rapidly under the action of the reagent, as in the endosperm of *Strychnos nux-vomica*, *Bauhinia*, and *Tamus*, the action need not be so prolonged, and the excessive swelling must be prevented by the use of alcoholic iodine at the outset, and in a similar manner it may be washed with alcohol instead of with water, otherwise the threads will be so displaced or altered as to be almost or entirely invisible.

As regards the management of the reagents, and the length of time they must be allowed to act to obtain a satisfactory result, the manipulation must be varied to a certain extent to suit the requirements of the various kinds of tissue, according as it is thick- or thin-walled, easily swollen or only with difficulty. The use of sulphuric acid is attended with a much greater amount of difficulty; for if it is allowed to act for too short a time, the cell-wall will not be sufficiently swollen; while if the treatment is prolonged, the middle lamellæ of the walls are liable to swell and at the same time stain, and will then hinder all successful observation of the threads which may traverse their substance. Upon still further action the protoplasm itself commences to be attacked. With chlor-zinc-iod, on the other hand, where the action is much more regulated and gradual, but little precaution as to length of time need be observed. Besides the difficulty of regulating its action, there are still other and grave objections to the use of sulphuric acid. One of these is that, no matter how carefully the acid is added to the tissue, and no matter how quickly the washing in water is accomplished, there will be a very considerable evolution of heat attending the hydration of the acid, which is liable to accelerate its action and to cause very grave changes in such delicate structures as fine protoplasmic threads traversing the cell-wall. The folding up and general displacement of the tissue consequent upon the action of such a violent reagent also greatly increases the already existing complications which attend all observations connected with minute histology.

For these reasons, while sulphuric acid is a very valuable reagent, both for swelling up resistent tissues on which chlor-zinc-iod has but little action, and for demonstrating in an unusually clear way the remarkable manner in which the apices of the protoplasmic processes, entering the pits, cling to the pit-closing membrane, it is, on the whole, the less satisfactory of the two, and the phenomena resulting from its action can only be rightly interpreted in the light of the more certain results obtained by the use of chlor-zinc-iod. For all

tissues which will swell sufficiently under its action, the chlor-zinc-iod method may be regarded as perfectly satisfactory; after treatment with picric-Hoffmann's-blue and subsequent washing with water, nothing but protoplasmic structures will be stained. In clear instances where a thick closing membrane is plainly traversed by threads, it can be demonstrated with ease that, while the individual threads are well stained, the substance of the pit-membrane itself undergoes no coloration, even when the section has been exposed to the action of the dye for a long time. When the pits are smaller and the threads less clearly defined, it is more difficult to observe that the substance of the pit-membrane is still free from coloration; and when, owing to the thinness of the closing membrane, all appearances even of striation cease to be recognizable, only an apparent staining of the entire membrane can be observed. Such staining points, however, in the opinion of the author, not to the coloration of the substance of the pit-membrane, but to the staining of protoplasmic threads traversing its structure.

Besides a platinum lifter, the author uses platinum needles, and is careful thoroughly to brush all the sections with a camel's-hair brush, both after the action of the acid or of chlor-zinc-iod and after staining.

To prove that the threads traversing the cell-wall are actually protoplasm, he employed with success a solution of molybdic acid in strong sulphuric acid, which has the advantage of swelling the cell-wall and at the same time colouring the protoplasm. The solution is colourless and gives a beautiful blue colour with alcohol and many other organic substances; and this reaction is extremely delicate. While not affecting the cell-wall for some time this reagent gives at once a fine blue coloration with protoplasm. If a section of some living endosperm, such as that of *Tamus*, is treated with it, the cell-wall will swell up, and it will commence to dissolve the protoplasm; the fine threads perforating the walls will remain for some time unaffected, but will soon be perceptibly coloured, while the main mass of protoplasm will assume an intense blue.

The pit-membrane itself possesses some properties different from those of the cell-wall. After staining with iodine and chlor-zinc-iod, while the cell-wall assumes the usual blue tint, the pit-membrane is but slightly coloured, and, when thin, appears as if not coloured at all, although the examination of a fine transverse section of the pit will prove that a definite staining has taken place. But the depth of the staining is less than might have been expected in proportion to the thickness of the membrane. Methylene blue stains both the wall and the pit-membranes a fine light blue, and, after the action of sulphuric acid, the swollen wall assumes a much lighter tint, owing to the fact that the quantity of the dye taken up by the cell-wall is now distributed over a larger space. If a section is cautiously treated with sulphuric acid, washed, and stained, it will be seen that, whereas the general swollen wall is coloured a light blue, the bottoms and the sides of the pit retain the darker blue colour of the unswollen cell-wall, and

will thus be clearly marked out. If, however, another section is treated for a longer time with acid, or the same section is a second time exposed to its action, no special coloration of the bottoms and sides of the pits takes place on staining, but the whole swollen wall is of a uniform light tint. This shows that the substance of the pit-closing membrane and of the layers immediately surrounding the pit-cavity are more resistent than the rest of the cell-wall; as indeed has already been pointed out by Strasburger.

Exactly the same phenomena are observed when a section, after cautious treatment with sulphuric acid, is stained with methyl-violet. In the case of methylene blue the protoplasm is not coloured, but when methyl-violet is used, a deep staining of that structure occurs, the tint of which is the same as that of the bottoms and sides of the pits; for, while the general cell-wall assumes a violet colour, the protoplasm, the pit-membranes and the sides of the pits appear of a deep purple. Now since protoplasmic processes from the main protoplasmic mass may project for some distance into the swollen pits, when such a stained section of pitted tissue is examined, it appears as if there were, in any two contiguous cells, threads of protoplasm of a purple colour traversing the thickness of the violet cell-wall by means of the pits, and thus establishing a direct continuity of the protoplasm from cell to cell. But after prolonged treatment with dilute glycerin, this purple colour dissolves from the pits, and the protoplasmic processes are left clearly seen, and may or may not be the means of establishing a continuity between the cells. As in the case of methylene blue, so also here, a more lengthy treatment of the tissue with acid will swell up the pit-membranes, and when in that condition the pits will assume the same colour as the rest of the cell-wall.

Method of Preparing Dry Microscopic Plants for the Microscope.*—G. Lagerheim has found the following method convenient for the examination of algæ or other plants which have already been dried.

A fluid is prepared of the following composition:—1 part fused potassium hydrate is dissolved in 5 parts water, and when the solution is complete 5·5 parts are added of glycerin of the consistency of a syrup. The dried desmids, Œdogoniaceæ or other algæ, are treated with water till they are thoroughly moist; a small piece of the material is then taken up with a pincette and placed upon the glass slide. One or two drops of the fluid are added, and the algæ distributed as evenly as possible with dissecting-needles. The glass slide is then warmed for a time over a spirit-lamp, and a cover-glass finally placed on. The potassium hydrate has now caused the previously shrunken algæ to swell and resume their original form. The addition of glycerin gives a consistency to the fluid, so that the algæ can easily be turned over by shifting the cover-glass, and thus observed on different sides, a point of great importance, for example, in the study of desmids.

* Bot. Centralbl., xviii. (1884) pp. 183–4.

The algæ prepared in this way can readily be drawn or measured. The cover-glass is carefully removed, and, if a low power or a dissecting Microscope is used, the object is taken up by a needle or stiff bristle, and again at once placed in potassium acetate or glycerin. If, on the contrary, the whole material thus prepared has to be got ready for drawing or measuring, a drop of acetic acid is added after removing the cover-glass. The algæ are in this way imbedded in potassium acetate and glycerin, fluids perhaps the best adapted of any for the preservation of algæ.

Dry mosses and fungi may also be prepared in the same way.

Chapman's Microtome.*—A. B. Chapman has devised a microtome, which has for its cutting surface two parallel glass-plates cemented to a block of mahogany, through which is inserted a brass cylinder at right-angles to the glass plates; in this cylinder (which forms the "well" of the microtome) an accurately fitted brass plug works, carrying on its top a flat-headed table-like piece which entirely prevents the imbedding agent from rising or turning round while the sections are being cut. The plug is moved up and down by a brass disk, which revolves between the block of mahogany and a similar block underneath. The brass disk is graduated on the edge of its upper surface, each graduation representing a movement of ·0005 in. of the plug. The microtome has a base-board which can be firmly clamped to a table, and the whole is so conveniently arranged that every operation or adjustment can be made at once, the whole being in view on the table.

Use of the Freezing Microtome.†—The tendency at the present time is to make all microscopic sections by the dry method after paraffin infiltration and imbedding; but no doubt there is a place, and an important one, for the freezing microtome in practical histology, and in this note S. H. Gage calls attention to what seem to him improvements in its use.

Disliking greatly the disagreeable mess made by ice and salt, it occurred to him to take advantage of the device of plumbers to thaw out water and gas pipes,—to use strong alcohol with the ice or snow instead of salt. By using snow or finely powdered ice and 95 per cent. alcohol, a temperature of 20 C. below zero is obtained within five minutes, and this temperature may be maintained with far less trouble than with ice and salt. The microtome used is the Rutherford pattern, modified by placing the drain near the top instead of in the bottom. A rubber tube passing from this drain to a jar preserves the overflow. It requires about 250 c.cm. of alcohol to freeze and keep frozen one tissue for cutting, but this is not lost, as little evaporation takes place, and the dilution does no harm for many purposes, hence the method is not wasteful, while it is much more pleasant and expeditious than with salt.

Ordinarily tissues are infiltrated with thick gum before freezing,

* Sci.-Gossip, 1884, p. 137.

† Science Record, ii. (1884) pp. 134–5.

and then the sections are soaked in a relatively large amount of water to remove the gum. Evidently while soaking, staining, and transferring the sections, especially if they be of such an organ as the lungs, there is every liability of their becoming folded or torn. This may be avoided by staining the tissue in the mass as for dry section-cutting, and then soaking in water to remove any alcohol, and finally completely infiltrating the tissue in a thick solution of very clean gum arabic.

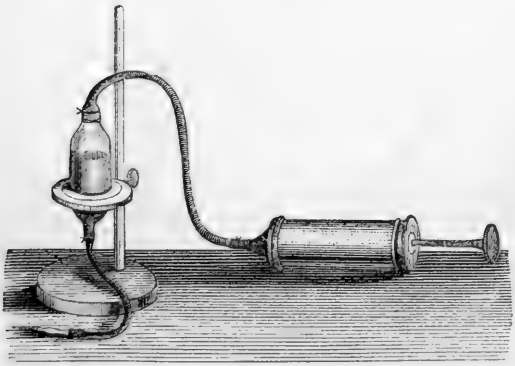
When ready to make the sections the well of the microtome is filled with the thick gum and the tissue introduced at the proper time as usual. Before cutting, the gum is cut away from the tissue as in sharpening very bluntly a lead pencil, then as the sections are cut they are transferred directly to the slide. After several slides are filled, a drop of glycerin is added to each section and the cover-glass applied. This is practically mounting in Farrant's solution.

Apparatus for Injection—Fearnley's Constant-Pressure Apparatus.—Very great variety exists in the forms of this class of apparatus. In the majority of them the leading principle is the compression of the air in an intermediate vessel by the entrance into it of a liquid falling from a greater or less height according to the pressure required, the air then acting on the injecting fluid in another bottle communicating with the first.

In the two following the intermediate vessel is dispensed with.

Ranvier's * (fig. 108) has a syringe connected by an indiarubber tube

Fig. 108.



with the bottle containing the injecting fluid, which is supported on a retort-stand. A second indiarubber tube terminates in the canula.

Ludwig's † (fig. 109) acts by the fall of quicksilver drop by drop into the vessel, A, containing the injecting fluid I.

* Thanhoffer's 'Das Mikroskop und seine Anwendung,' 1880, p. 187 (1 fig.).
† Ibid., p. 188 (1 fig.).

Toldt's * (fig. 110) is similar to the preceding, but in addition to the vessel containing the injecting fluid, a second air-vessel is introduced.

Thanhoffer's.† Prof. L. v. Thanhoffer uses the following apparatus (fig. 111). To the wall of the room and near the ceiling a board is fixed. This board carries a pulley, over which a cord is passed, having at one end a large glass vessel A, filled with water; at the other end of the cord is a handle, by which the vessel can be drawn up and down as required. When the tap in A is open, water flows through the india-

FIG. 109.

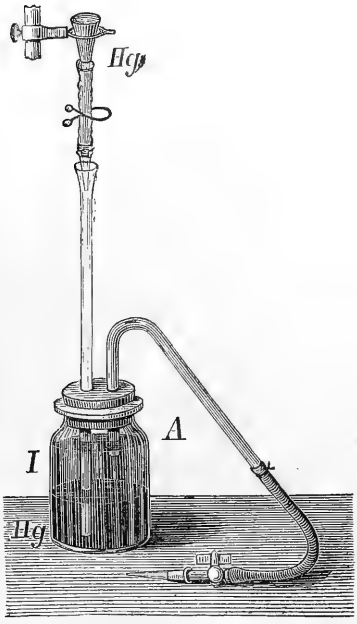
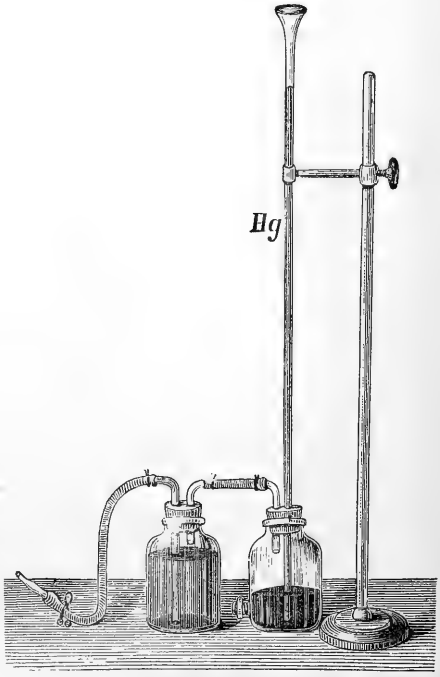


FIG. 110.



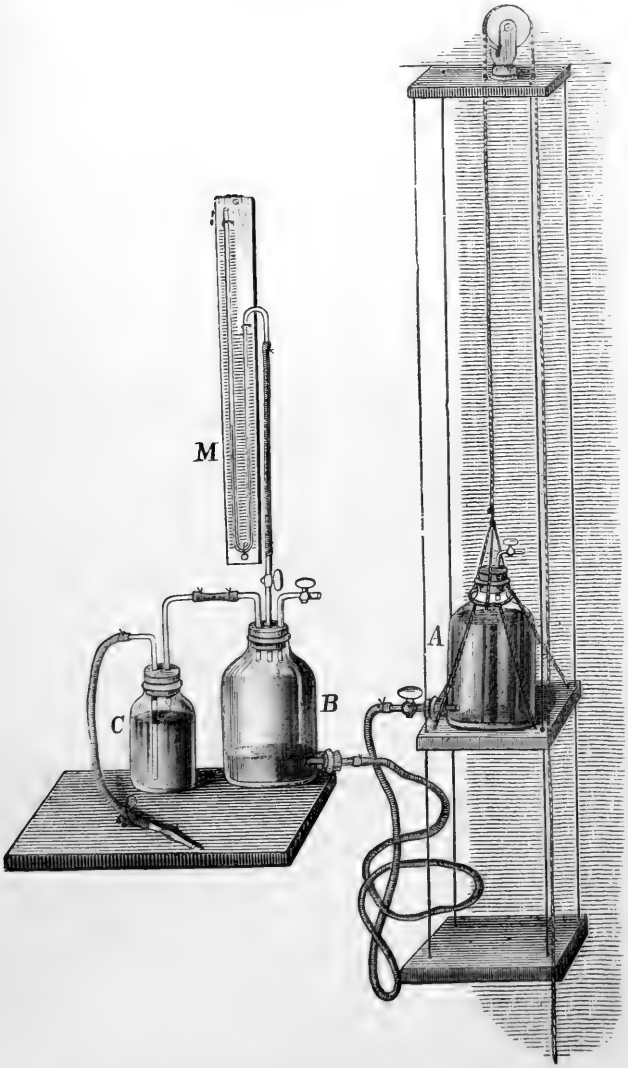
rubber tube into a second vessel B, which acts as an air-reservoir. The air compressed in B passes into C, which contains the injecting fluid, and forces it through the discharge pipes and thence into the vessels. The pressure is of course increased according as A is raised. The amount of pressure is denoted by the manometer M. Quicksilver may be substituted for water, and greater pressure thereby obtained,

* Thanhoffer's 'Das Mikroskop und seine Anwendung,' 1880, p. 189 (1 fig.).

† Ibid., pp. 190–2 (1 fig.).

but in injecting fine vessels this is quite unnecessary, for if the room be sufficiently lofty a pressure of from 300 to 400 mm. can be obtained

FIG. 111.



by drawing the vessel A to the ceiling, a pressure which is more than is required.

Ludwig's * (fig. 112) for quicksilver and small pressure, is substantially identical, and requires no explanation beyond the figure.

Fig. 112.

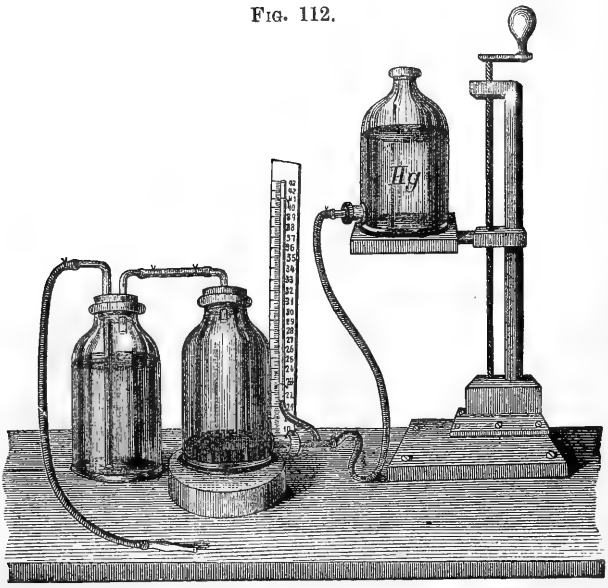
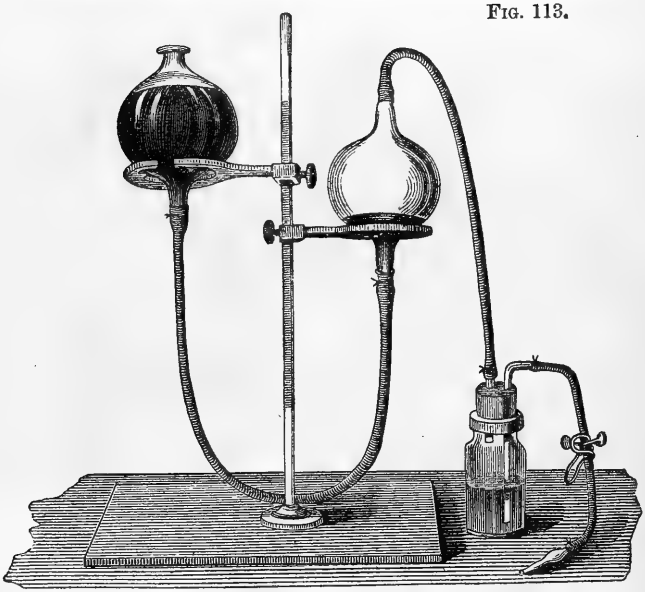


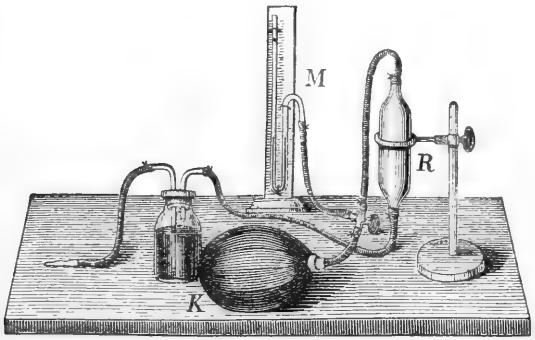
Fig. 113.



* Thanhoffer's 'Das Mikroskop und seine Anwendung,' 1880, pp. 192–3 (1 fig.).

Ranvier's * (fig. 113) consists of a glass vessel filled with quicksilver which can be raised and lowered on a retort-stand. The rise of the quicksilver in the intermediate vessel compresses the air which it contains as well as that in the bottle containing the injecting fluid, which is forced out as in the previous case. In another form (fig. 114)

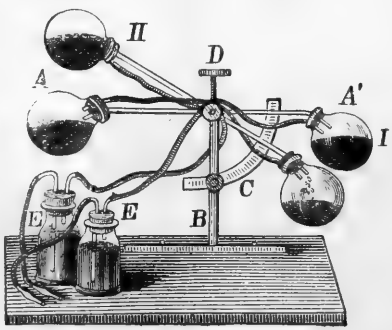
FIG. 114.



the pressure is obtained by compression of an indiarubber ball K communicating with an air-reservoir R (M being a manometer).

Hering's † (fig. 115) consists essentially of two glass bulbs, A A′, having a thin glass tube passing through the stoppers in their necks, and by which the bulbs communicate with each other. A flexible tube from each bulb passes into one or other of the bottles E E, containing the injecting fluid. The ends of the glass tubes are drawn out so fine that the quicksilver passes only a drop at a time from one to the other (even when the air is compressed). When the bulbs are turned on their axis, and instead of the horizontal position I., take the oblique one II., the quicksilver will flow from A to A′, and compress the air in the bulb A′, and act upon the injecting fluid in the vessel E. The nearer a vertical position is approached, the greater the pressure will be by which the injecting fluid is forced into the blood-vessels. The two bottles, E and E, are alternately used according as one or the other of the bulbs is uppermost.‡

FIG. 115.



* Thanhoffer's 'Das Mikroskop und seine Anwendung,' 1880, pp. 189–90, 187–8 (2 figs.).

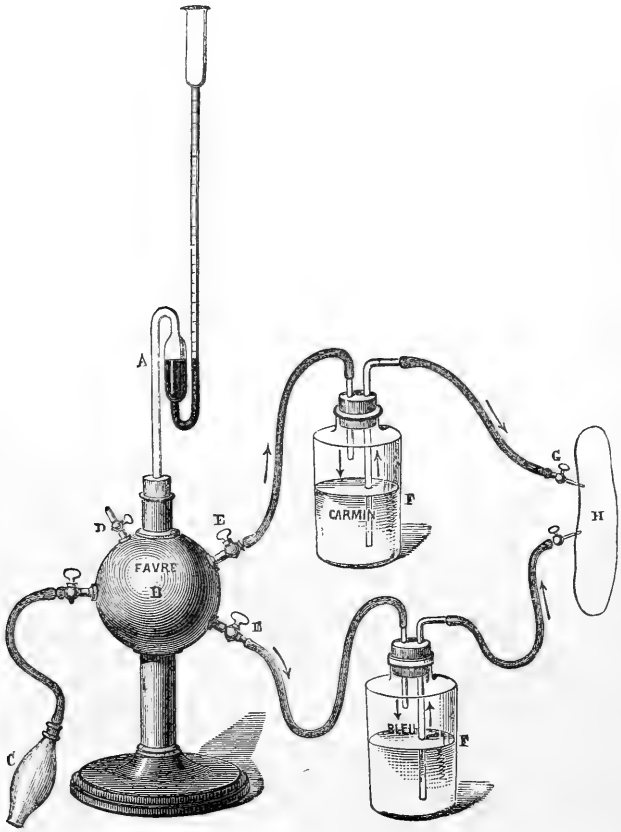
† Ibid., pp. 193–4 (1 fig.).

‡ The figure, which is a cliché of the original, should have indicated one of the two positions of the bulbs by dotted lines. As drawn, there appear to be four bulbs. B, C, and D are not explained but their function is obvious.

Other forms are described by Dr. P. Latteux in his 'Manuel de Technique Microscopique.'

Dr. Latteux's * (fig. 116) consists of a copper globe B, to hold the compressed air, having a tube at A with mercury serving as a manometer. Four taps are inserted in the globe of which one is the air

Fig. 116.



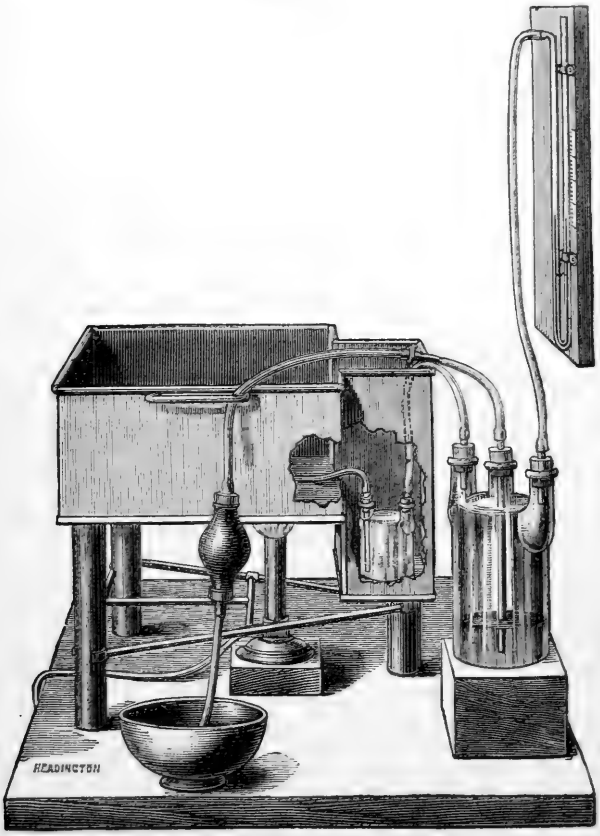
tube from the indiarubber ball C, another regulates the pressure, and the third and fourth E E communicate with two bottles F F containing carmine and blue, the exit tubes G H from these bottles terminating in canulæ for insertion in a vein and artery, or artery and gland duct.

* Latteux, P., 'Manuel de technique microscopique,' 2nd ed., 1883, pp. 110–12 (1 fig.).

The apparatus is sufficient to completely fill the finest vessels of the retina, spinal cord, &c.

*Fearnley's Constant-Pressure Apparatus.**—The method of Ludwig has always been acknowledged as superior to injecting by the syringe except for the one great obstacle—applying the necessary pressure, which had to be effected by elevating and depressing huge water-

FIG. 117.



bottles or by connecting the air-pressure bottle with a water-tap and regulating the pressure as best one could, thus rendering the pressure almost as uncertain and irregular as the thumb-pressure of the syringe. Mr. W. Fearnley's method is to apply the pressure with an ordinary Higginson's enema syringe (figs. 117 and 118).

No practice is required with this simple contrivance beyond introducing and tying in the nozzle in the aorta.

* Brit. Med. Journ., 1883, pp. 859-60 (2 figs.).

There is a bath, having a shallow part for the animal to lie in, and a deeper part for the Woulff's bottle, containing the injection-mass, to stand in. A large (40 ounce) Woulff's bottle, with three necks, is fitted with three perforated indiarubber stoppers. The middle stopper is perforated with a glass tube which goes to the bottom of the bottle. Each of the others is perforated with a glass tube, the depth of the stopper only, and standing above the stopper sufficiently to admit of a piece of indiarubber tubing being fixed upon it. The Woulff's bottle containing the mass has two necks, fitted with indiarubber stoppers. One neck admits a piece of glass tube, which goes quite to the bottom of the bottle; the other admits a short piece of tube the depth of the stopper only. Fig. 117 shows all further detail.

The mercurial manometer allows five inches rise of the mercury in the ascending arm—therefore five inches fall of the descending arm —though four inches will do.

"To inject an animal, a rabbit, for instance, proceed as follows:— Fill the bath with water, and heat the water with a Bunsen's burner to 100° Fahr. or so. The Woulff's bottle containing the mass should be filled and thoroughly stoppered. Then chloroform the rabbit and make an L-shaped incision into the thorax, so as to expose the heart and aorta. This is done by cutting up the middle line of the sternum (breast-bone) as far as the root of the neck nearly, then making a second incision at right angles to this to the rabbit's left. A triangular flap is thus made, and the heart inclosed in the pericardium exposed. Having cut through the pericardium, seize the apex of the heart with a pair of forceps and snip it off, then the heart's apex appears as in A, fig. 118. That is to say, the right and left ventricles are opened, and the animal instantly bleeds to death. Mr. Fearnley uses a nozzle, as in B, Fig. 118, which has an elastic collar *e c*, which is plugged by a nozzle, as here shown.

The opening in the right ventricle leading to the pulmonary artery has a crescent shape or slit-like appearance; whilst the opening in the left ventricle, leading to the aorta, is round. Therefore, if we wish to inject the entire arterial system, we insert our nozzle into the round hole; but if we wish to inject the pulmonary system only, we choose the crescentic slit.

Either glass nozzles,* or those shown in fig. 118, are to be inserted into one or other of the two holes (usually the round one for injecting the entire arterial system with carmine and gelatine mass). We can now either tie the artery only, or we can tie the whole heart substance. In either case a ligature of floss silk is to be passed round (the artery or the entire heart) and tightly tied and secured. Before proceeding further, we wash out the cavity of the thorax of all blood to keep our bath water clean, then we lift the animal into the bath and there let it remain ten minutes or so to get well warmed. It is a good plan to slit open the entire abdomen in the middle line, so as to allow the

* Mr. Fearnley informs us that he now uses glass nozzles with tube connections, which answer quite as well as those figured, and are cheaper.

warm water to freely get round the abdominal contents: the mass thus gets into every organ and into every part of an organ evenly.

We now connect the pressure bottle with the manometer and with the Higginson's syringe, as shown in fig. 117, also with the mass bottle. The tube of the mass bottle, which is to convey the mass away from the bottle, is now clamped, as shown at C, fig. 118, and must never for an instant be allowed to get out of the warm water into the cold air.

Fig. 118.

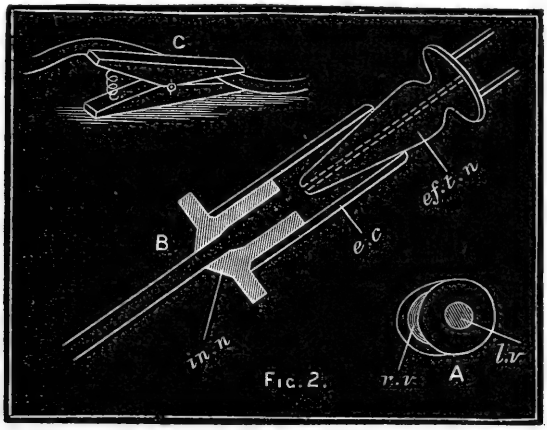


Fig. 2.

Having our small basin full of water, we now squeeze the Higginson's syringe, watching the manometer, to raise the mercury half an inch. This done, we remove the clamp from the efflux tube, and the red fluid after driving out a few air-bubbles begins to flow out; we at once make the connection, and all quicksands are passed if we have tied in our nozzles properly into the artery and the connecting part, and fastened in our stoppers thoroughly into our Woulff's bottles.

Our task is easy now: all we do is to seize the head of the animal, which should be to our left, with our left hand, to watch the pale gums, tongue, and eyelids become suffused with a pale blush which gradually deepens, whilst we gently squeeze and relax the barrel of the syringe and glance at the mercury from time to time. When the mercury has risen four, or at most five inches, the whole animal will be completely injected: the visible mucous membranes and bowels will be dark-red and much swollen.

We now remove the animal, and place it in ice-cold water under a common water-tap for an hour or two, and divide it into parts as required. This method of applying pressure is wonderfully delicate; thus, whilst we can raise the mercury in the manometer almost imperceptibly, one entire compression of the barrel raises the mercury one inch."

Myrtillus for Staining Animal and Vegetable Tissues.*—Dr. M. Lavdowsky (in furtherance of the modern fashion of recommending every conceivable substance which by any chance will furnish a stain) recommends the berries of *Vaccinum myrtillus*, as an excellent staining agent for the nuclei of all cells and the cellulose walls of plant-cells. The karyokinetic figures are shown very plainly.

The fresh berries should be well washed in water, the juice squeezed out and mixed with two volumes of distilled water, to which some alcohol (90 per cent.) has been added. It is then heated for a short time, and filtered warm. For use, a small quantity of the fluid should be diluted with two or three times its bulk of distilled water.

The stain gives a red (carmine) colour with fresh neutral objects, or lilac (hæmatoxylin) when the acid of the fluid is neutralized by an alkali or neutral salt. The latter is the more durable. A double stain is obtained by placing the object in a solution of eosin after treatment with the lilac stain. Directions are given for applying the fluid, but it does not appear to us, from the author's own showing, to be a valuable or even useful addition to the already long list of staining agents.

Hartzell's Method of Staining Bacillus tuberculosis.†—A small quantity of sputum is spread as thinly and evenly as possible upon a slide, and allowed to dry, and is then passed slowly several times through the flame of an alcohol lamp or Bunsen burner. One or two drops of the fuchsin solution recommended by Gradle (prepared as follows: carbolic acid 15 minims, distilled water 1/2 fluid oz., dissolve, and add saturated alcoholic solution of fuchsin 1/2 fluid dr.) are placed upon the sputum, and allowed to remain from three to five minutes. The slide is now washed thoroughly with distilled water, to remove the excess of fuchsin, and the stained sputum completely decolorized by a saturated solution of oxalic acid. It is again thoroughly washed in distilled water, and allowed to dry; it is now ready to be mounted in glycerin or balsam for examination. With a power of 500 or 600 the bacilli will appear as brilliant red rods, no staining of the background being necessary.

One chief advantage claimed over other methods is that in the latter the decolorizing agent employed is dilute nitric acid; but this, besides being disagreeable to handle because of its corrosive and staining properties, is apt to remove the colour from the bacilli too, unless great care is taken. Oxalic acid, however, seems to leave the dye untouched in them.

Safranin Staining for Pathological Specimens.‡—For staining tumours, Dr. V. Babes(in) recommends that fine sections of tissue hardened in alcohol or chromic acid should be steeped either in a solution of safranin which has been dissolved in warm water, or in a mixture of equal parts of concentrated watery and concentrated

* Arch. f. Mikr. Anat., xxiii. (1884) pp. 506–8.
† Amer. Mon. Micr. Journ., v. (1884) pp. 76–7, from 'Medical Times.'
‡ Arch. f. Mikr. Anat., xxii. (1883) pp. 356–65.

alcoholic safranin solution for half an hour; they should be washed slightly in water, and then dehydrated as quickly as possible by absolute alcohol, then transferred to turpentine and mounted in balsam. Some tissues which are not so readily decolorized may be clarified with oil of cloves. Although they appear scarcely red, yet such sections show the following structures: viz. nucleoli of white blood-corpuscles; granules in the same and in most cells of rapidly proliferating granulating tissues; periphery of red blood-corpuscles; filamentous bodies occurring in connection with blood-vessels in process of formation; nuclei of giant-cells and nucleoli of all large-celled sarcomata and carcinomatous tumours.

As the inactive, skeletal part of the nucleus is not stained by the safranin, it is easy to follow by its means the part which the nucleolus plays in cell-division. In large-celled, malignant tumours a great variety of forms are thus brought out in the nucleus, while the spindles and the fibrils connecting them remain uncoloured. In melanosarcoma the fission-stages of the cells, which remain concealed under every other treatment, are well brought out, and in rapidly growing small-celled tumours, e. g. lymphosarcomata, the appearance of universal staining is imparted to the cell by a series of delicate nuclear markings which almost fill the cell.

Secondly, for investigating the structure of the cell and of other histological elements a super-saturated solution should be employed; it is warmed to 60°, and filtered in this state; the sections are placed in a small quantity of the liquid in a watch-glass, which is then warmed * for a few seconds over a spirit-lamp until the precipitating crystals are redissolved; the sections are left for a minute, then washed in water, and treated as in the former case. Tissues which do not stain readily should be warmed again and again. The nuclear network comes out well under this treatment. It is especially adapted for delicate structures and for bacteria; every micrococcus appears brownish-red, while the surrounding tissues assume a fine rose-red; the bacilli of tuberculosis and lepra are not thus stained.

Thirdly, the sections may be left for 12 to 24 hours in the solution (either concentrated watery or alcoholic, or a mixture of the two). Sections thus coloured may be left, if necessary, somewhat longer in alcohol, turpentine, oil of cloves, or, better, origanum; a large number of details are thus brought out, and a similar effect is produced by longer action of a watery solution; the method is especially adapted to tumours of the brain or spinal cord.

The finest representations of the changes undergone by nuclei in fission were produced by rapidly staining with safranin, followed by eosin, and mounting in balsam. Safranin and hæmatoxylin bring out the nuclear skeleton violet and the nucleolus red. Preparations made according to these methods have proved durable. Some points are better seen by mounting in glycerin, but the colour disappears more or less in time, and acetate of potash is preferable both on the grounds of permanency and clearness.

* Cf. this Journal, iii. (1883) p. 918.

Preparations which show only the muscular fibre and the elastic tissue may be made by staining small fragments with a mixture, half and half each, of oil of cloves or origanum and concentrated alcoholic solution of safranin and placing for an hour under the air-pump: sections may then be made at once, or, better, uncoloured sections may be transferred from alcohol to the oily solution; the sections are washed with solutions of caustic potash in alcohol, and mounted in acetate of potash. By putting sections stained with safranin into 30 to 40 per cent. solution of caustic potash the colour is fixed, and the elements come out very distinctly; they should be mounted in acetate of potash.

Collodion as a Fixative for Sections.*—Sections fixed by means of a solution of collodion in clove oil, as suggested by Schällibaum,† may be coloured on the slide. S. H. Gage, who had begun to experiment with collodion before Schällibaum's method was published, recommends that the collodion and clove oil be applied separately.

"A solution of collodion is prepared by adding to 2 gr. of gun-cotton (that used by photographers is good) 54 cc. of sulphuric ether and 18 cc. of 95 per cent. alcohol. After the gun-cotton is entirely dissolved the solution should be filtered through filter-paper or absorbent cotton. The slides are coated by pouring the collodion on one end, allowing it to flow quickly over the slide, and off the other end into the bottle. The prepared slides should be kept free from dust. As the collodion will not deteriorate after drying on the slide, any number of slides may be prepared at the same time. Before using a slide it should be dusted with a camel's-hair brush, and with another brush the collodionized surface of the slide should be thinly painted with clove oil. . . . . The sections are arranged as in the shellac method. The slide is warmed over an alcohol lamp, and then heated in a warm chamber, so as to drive off the clove oil. After cooling, it may be placed in a wide-mouthed vial of turpentine, chloroform, xylol, or refined naphtha, to remove the paraffin. Naphtha is very cheap, and is the best agent we have yet tried for dissolving the imbedding mass. The sections are usually freed from imbedding mass within half an hour, though the slide may remain in any of the solvents mentioned for two or three days, or perhaps indefinitely, without loosening the sections. When the slide is removed from the naphtha, the sections are washed with 95 per cent. alcohol by means of a medicine dropper, or by immersing the slide in alcohol. If the sections are to be stained in Kleinenberg's hæmatoxylin, or in any other stain containing 50 per cent. or more alcohol, the slide is transferred directly from the alcohol used for rinsing to the staining agent, otherwise it should be first transferred to 50 per cent. alcohol, and from that to the staining agent. Whenever the sections are sufficiently stained, they may be mounted in any desired mounting medium. In case Canada balsam is to be used, the slide must be immersed in alcohol to wash away the stain, and finally in

* Medical Student (N. Y.), i. (1883) pp. 14–6.
† See this Journal, iii. (1883) p. 736.

95 per cent. alcohol to completely anhydrate the sections. They are cleared with a mixture of carbolic acid 1 part, turpentine 4 parts. The balsam to be used is prepared by mixing 25 gr. of pure Canada balsam with 2 cc. of chloroform and 2 cc. of olive oil. The latter very soon removes any cloudiness that may have appeared in the collodion film."

Piffard's Slides.—Mr. B. Piffard has patented a slide which is made by forming with a diamond a round recess in an ordinary slide. In this the object is placed, and covered with thin glass. The upper surface of the slide is thus perfectly smooth, the cover-glass being even with the slide. There is no danger of the cover-glass and object being knocked off; and the recess causes a very beautiful diffusion of light.

Mounting in Balsam in Cells.*—R. P. H. Durkee describes the following process:—A curtain-ring, flattened by pressure, is placed upon a clean slide and the slide placed on the hot table. Drop in the centre a small portion of balsam, enough to fill the cell, and heat till the air-bubbles rise and permit of breaking with the needle; at the same time gently moving the ring about, and pressing it down to insure contact with the slide. Place the object in the balsam, taking care to see that it is completely covered; warm the cover and place it in position, in doing so holding it in the forceps parallel with the surface of the slide, so as to expel the air all round. Weight down with a bullet, and apply heat as may be necessary to harden the balsam.

What the author considers a feature is that there would seem to be no possibility of varnish running in, the channel in the top of the ring receiving the excess of balsam when pressed out by the cover, and thus forming a barrier to the influx of the varnish used in ringing. For flattening the rings he used two plates of brass, 2½ in. square by 1/8 in. thick. Place the rings, six or more at a time, between the plates, and press in a lever stamp. This method of mounting seems to him to have the following desirable features, viz. no previous preparation and drying of cells, rapidity and neatness of finish, and no running in of varnish.

Styrax, Liquidambar, Smith's and van Heurck's Media.—Dr. H. van Heurck writes that styrax, when prepared by exposing the raw product to the air and light, dissolving and filtering, is no longer of a dark colour, and that its index is higher than 1·585, as given on p. 475. The purified styrax of commerce is always darker and of lower refractive index. Preparations become completely colourless at the end of a few months, especially if brought into the light occasionally, and the index rises a little.

Liquidambar can be obtained of Lamman and Kemp, William and Cedar Streets, New York. It must be heated to reduce its brittleness, and dissolved by means of the water-bath in a mixture of

* Amer. Mon. Micr. Journ., v. (1884) pp. 84–5.

alcohol and benzine, and filtered. This is also the best solvent for styrax.

Styrax and liquidambar, purified and prepared according to Dr. van Heurck's directions, can be obtained of Messrs. Rousseau, 42–44, Rue des Ecoles, Paris.

Prof. Smith's medium, while most excellent for difficult diatoms of delicate structure, is not better than styrax for ordinary diatoms and preparations of histology or of insects.

Dr. van Heurck also announces that he has discovered a colourless medium analogous to that of Prof. Smith, but with an index higher than liquidambar.

Grouping Diatoms.*—J. Deby calls attention to some slides prepared for him by Möller, each containing many species of the same genus arranged in several lines. Thus there are 72 species or varieties of *Triceratium*, 60 of *Nitzschia*, 45 of *Surirella*, 38 of *Epithemia*, &c. Such slides have, Mr. Deby considers, enormous advantages over the "type-plates" from the point of view of the comparative study of the species of a genus. Equally to be recommended, from a scientific point of view, is, he thinks, the plan by which as many species as possible from the same gathering are united in one slide.

Quantitative Analysis of Minute Aerial Organisms.†—In the reports of the Imperial German Board of Health is a paper on this subject by Dr. Hesse. He employed an apparatus, which in all essentials so corresponds with the portable aëroscope of Dr. Maddox described in this Journal, III. (1883) p. 338, that it is necessary to note the fact, as no reference is made to it by Dr. Hesse. Instead, however, of drawing the air direct into an aëroscope and on to a thin cover-glass smeared with a glutinous substance for examination of the deposited matter by the Microscope, a long tube lined with a layer of gelatine is used. The air is allowed to enter by an aperture at one end, that most suitable being of like diameter with that of the exit tube, and as it traverses the tube slowly it deposits the organisms in its passage.

According to the nature of the deposits, small colonies are developed in the gelatine at different parts of the tube. By employing a long tube and slow traverse of air, the bacteria are deposited before reaching the exit, while the fungi—mildew and spores—appeared more abundant at the exit end than at the entrance. That bacteria are rapidly deposited in tranquil spaces was long since shown by Professor Tyndall.

Microscopical Evidence of the Antiquity of Articles of Stone.‡—An action has recently been pending in New York as to the genuineness of the collection of antiquities brought from Cyprus by Count Di Cesnola and sold to the city.

Mr. B. Braman, President of the New York Microscopical Society,

* Journ. de Microgr., viii. (1884) pp. 230–1.

† MT. aus dem K. Gesundheitsamte, ii. Berlin, 1884.

‡ Amer. Mon. Micr. Journ., v. (1884) pp. 14–5, from New York *Times*, 22nd Dec., 1883.

was examined as a witness and detailed the result of his examination with the Microscope of the surfaces of the statues in the collection.

"The Cypriote stone whereof these statues are sculptured is a cellular calcareous tufa. The cells are minute and crowded. There are about 1500 to the square inch. They are spherical in shape, and about 1/100 in. in diameter. When freshly cut, it will be found that the walls of some cells are harder than the walls of others. The hard walls resist the effects of the atmosphere with more success than the softer ones. During exposure these soft spaces sink first, and leave the hard ones standing, like craters on the face of the moon. The soft spaces sink into dome-like shapes, and small orifices indicate that the atmosphere has begun to affect them. Then the cups thus formed are carried away, the hard projections roll off in small globes, and the process recommences. Each process occupies several centuries. In the case of buried objects in Cyprus, the water filtering through the ground makes a deposit on them, more or less thick, of carbonate of lime. I have given seven or eight hours to the microscopical examination of the statuette of Venus, and it is susceptible of scientific demonstration that the surface of the so-called mirror and the surrounding surface are ancient. On the mirror are eight stipples of carbonate of lime, deposited in the way I have stated, which are an integral part of the ancient surface, and would not appear on a freshly cut surface. These evidences of antiquity could not be taken away without breaking the stone. They fill the cavities whereof I have spoken. They appear on the surface of the drapery within 3/16 in. of the mirror's outline. My Microscope would have disclosed cement 1/1000 in. in thickness."

"B.Sc."—Carbolic Acid and Cement.

[Fresh-water Algæ mounted three years ago in a weak carbolic-acid solution with asphaltum for the cement are still perfectly good.]

Sci.-Gossip, 1884, p. 137.

BRIANT, T. J.—Notes on putting up Microscopic Objects.

Rep. South Lond. Micr. and Nat. Hist. Club, 1884, p. 13.

Chapman's (A. B.) New Microtome.

[*Supra*, p. 642.] *Sci.-Gossip*, 1884, p. 137.

COLE, A. C.—Methods of Microscopical Research.

Part XI. Mounting (*continued*). pp. lvii.–lxi. (Mounting the Diatomaceæ. Cleaning and Mounting Polycystina. Preparation and Mounting of Insects. Preparation of Vegetable Sections. To Double Stain Vegetable Sections.)

Part XII. pp. lxiii.–lxxii. On Microscopical Drawing and Painting (by E. T. D.).

" " Popular Microscopical Studies. IX. pp. 39–42. The Crane Fly (*Tipula Oleracea*). Plate 9 × 40.

No. X. pp. 43–6. Sponge. Plate 10.

No. XI. pp. 47–52. Starch. Plate 11 (*Sarsaparilla officinalis* × 400).

" " Studies in Microscopical Science.

Vol. II. No. 19. Sec. I. No. 10. pp. 37–40. Nerve of Horse. Plate 10. T. S. × 150.

No. 20. Sec. II. No. 10. pp. 39–42. Vascular Tissue (*continued*). Plate 10. Wood Vessels and Cells.

Vol. II. No. 21. Sec. I. No. 11. pp. 41–4. Human Cerebellum. Plate 11. T. S. × 150.

No. 22. Sec. II. No. 11. pp. 43–6. Fundamental Tissue. Plate 11. T. S. Petiole of *Limnanthemum* × 75.

D., E. T.—See Cole, A. C.

Decker, F.—Ein neuer Schnittstrecker. (A new section-smoother.) [*Post.*]
Arch. f. Mikr. Anat., XXIII. (1884) pp. 537–43 (2 figs.).

Francotte, P.—Description des différentes méthodes employées pour ranger les coupes et les diatomées en séries sur le porte-objet. (Description of the different methods adopted for mounting sections and diatoms in series on the slide.) *Continued.* *Bull. Soc. Belg. Micr.*, X. (1884) pp. 137–41.

" " Petit instrument qui permet de repasser sur le cuir les grands rasoirs du Microtome de Thoma. (Small apparatus for sharpening on the strop the large razors of Thoma's Microtome.) [*Post.*]
Bull. Soc. Belg. Micr., X. (1884) pp. 151–2.

Friedländer, C.—Microscopische Technik zum Gebrauch bei medicinischen und pathologisch - anatomischen Untersuchungen. (Microscopical Technic in medical and pathological-anatomical researches.) viii. and 123 pp. and 1 pl. 2nd ed. 8vo, Berlin, 1884.

Griffin, A. W.—On the Collection and Preparation of the Diatomaceæ. Part I. Collection.
["An attempt to gather together some of the ideas of the best authorities on the question, for the benefit of those whose want of leisure precludes them from searching out these facts for themselves."]
Journ. of Micr., III. (1884) pp. 138–46.

Hillhouse, W.—Preparing Schultze's Solution. [*Post.*]
Proc. Cambridge Phil. Soc., IV. (1883) p. 399.

Hitchcock, R.—Microscopical Technic. V. Mounting in gelatinous and resinous media. *Amer. Mon. Micr. Journ.*, V. (1884) pp. 109–12.

" " See Insects, catching small.

" " See Mounting, questions about.

Insects, catching small.
[Mounting needle bent into a hook and dipped in alcohol. Dip the needle into alcohol (or concentrated carbolic acid—R. Hitchcock) to free the insects.]
Amer. Mon. Micr. Journ., V. (1884) p. 118.

Jackson, E. E.—Mounting the Skin of a Silkworm.
[Soak in acetic acid for 10 days, then open carefully with scissors from anus to mouth and wash in water. Soak in weak and then strong alcohol, follow with oil of cloves, turpentine, and balsam.]
The Microscope, IV. (1884) p. 133.

Kidder, J. H.—An examination of the external air of Washington.
[Describes and figures an aëroscope in principle "not essentially different from those devised by Pouchet, Maddox, and Cunningham." By bending the tube of the funnel at right angles the glycerine is prevented running off, as is the case when the smeared glass is set vertically.]
Journ. of Micr., III. (1884) pp. 182–5 (1 pl.).

Kingsley, J. S.—Microscopic Methods. I.
[No. II. was given *ante*, p. 484, the Part containing I. having been lost in the post.]
III. Hardening and macerating.
Science Record, II. (1884) pp. 108–10, 155–60.

Lavdowsky, M.—Myrtillus, ein neues Tinctionsmittel für thierische und pflanzliche Gewebe. (Myrtillus, a new staining medium for animal and vegetable tissues.) [*Supra*, p. 652.]
Arch. f. Mikr. Anat., XXIII. (1884) pp. 506–8.

Loew, O.—Ueber den mikrochemischen Nachweis von Eiweissstoffen. (On the microchemical analysis of albuminous substances.) [*Post.*]
Bot. Ztg., XLII. (1884) p. 273.

Mounting, questions about.
[As to the cracking of the covers of Möller's slides; also as to bubbles, and note by R. Hitchcock. "Bubbles are occasionally left in fluid mounts, especially when the cells are deep, under the impression that the air they contain being very elastic prevents injury to the cell from internal pressure when the temperature rises. We confess to grave doubts if such bubbles are of any benefit whatever."]
Amer. Mon. Micr. Journ., V. (1884) p. 119.

NEGRI, A. F.—Coloration des Spores dans les Bacilles de la Tuberculose. (Staining the spores of the Bacilli of Tuberculosis.) [*Post.*]
Journ. de Microgr., VIII. (1884) pp. 349–51, from 'Lo Sperimentale.'

Piffard's (B.) Improved Microscopic Slides. [*Supra*, p. 655.]
Sci.-Gossip, 1884, p. 136.

POIGNAND, M.—The Microscope in Palæontology. [*Post.*]
Journ. of Micr., III. (1884) pp. 163–70 (1 pl.).

PRINZ, W.—Examen microscopique (1) d'une feuille de papier qui a servi à isoler les plaques du parafoudre de la station de Lebbeke; (2) des lames minces d'un morceau de poterie. (Microscopical examination (1) of a piece of paper used to isolate the lightning conductor of the station of Lebbeke; (2) of thin plates from a piece of pottery.)
Bull. Soc. Belg. Micr., X. (1884) pp. 152–4 (3 figs.).

RALPH, T. S.—Results of a Microscopical Investigation of the action of Ammonium Molybdate and other chemical agents on the vascular and cellular tissues of about 120 different plants. *Journ. of Micr.*, III. (1884) pp. 155–62.

RATABOUL, J.—Les Diatomées. Récolte et préparation. (The Diatomaceæ. Collection and preparation.) *Continued.*
Journ. de Microgr., VIII. (1884) pp. 342–5.

ROBSON, M. H.—Improvements in Microscopic Slides.
[Records his experiments of five years ago to make slides similar to Piffard's, *supra*.]
Sci.-Gossip, 1884, p. 162.

Section-smoother, a simple.
[Practically identical with P. Francotte's, *ante*, p. 315.]
Science Record, II. (1884) p. 112 (1 fig.).

SIDDALL, J. D.—The Microscopical Examination of Milk and Drinking Water.
Micr. News, IV. (1884) pp. 187–9.

SLACK, H. J.—Pleasant Hours with the Microscope.
[Examining flowers of Borage, Comfrey, &c.—Ixodes.]
Knowledge, V. (1884) pp. 430–1 (2 figs.), 472–3 (2 figs.).

STOWELL, C. H.—Studies in Histology. III. Section Cutting.
The Microscope, IV. (1884) pp. 123–7.

" " New Apparatus.
[Griffith's Turntable, *post*. German Microtome.]
The Microscope, IV. (1884) pp. 131–2.

TAYLOR, T.—Clearing fluid.
[About equal parts of Squibb's absolute alcohol and Eucalyptus oil forms a very good clearing fluid for animal or vegetable tissues. When the tissues are freshly cut, place them in commercial alcohol for a few minutes. Next transfer them to the clearing fluid, as above described, for a period of about ten minutes. They are next placed in pure Eucalyptus oil, which removes the alcohol; a few minutes' immersion will suffice. It is not well to keep tissues longer than necessary in the fluid. Vegetable tissues become hardened when kept several days in it.]
Amer. Mon. Micr. Journ., V. (1884) p. 119.

UNDERHILL, H. M. J.—Mounting Infusoria.
[Reports his failures with osmic acid, permanganate of potash, and "chromic oxydichloride" acid.]
Sci.-Gossip, 1884, p. 162.

White Zinc Cement.
[Note on the difference of opinion between Mr. R. Hitchcock and Professor C. H. Stowell, *ante*, p. 485. "Perhaps they are not speaking of the same preparation of white zinc."]
Micr. Bull., I. (1884) pp. 28–9.

PROCEEDINGS OF THE SOCIETY.

MEETING OF 11TH JUNE, 1884, AT KING'S COLLEGE, STRAND, W.C., THE PRESIDENT (THE REV. W. H. DALLINGER, F.R.S.) IN THE CHAIR.

The Minutes of the special and ordinary meetings of 14th May 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
Heurck, H. van.—Synopsis des Diatomées de Belgique—Table Alphabétique. 120 pp. 8vo, Anvers, 1884	*The Author.*
James, J. B.—Aids to Practical Physiology. viii. and 24 pp. 8vo, London, 1884	*Mr. Williams.*

Mr. Crisp called attention to the extraordinary character of the latter book, and read extracts from it (*supra*, p. 629).

Mr. Crisp described Prof. Zenger's method of constructing "Endomersion" objectives by using a mixture of ethereal and fatty oils, which he claimed enabled the chromatic aberrations to be much more effectively dealt with (*supra*, p. 616). He exhibited an objective sent by Prof. Zenger.

Mr. J. Mayall, jun., in reply to Mr. Crisp, said that he had examined the objective exhibited, and found that it was not a 1/50 in., as claimed, but in truth not more than 1/8 in. He also found that the spherical aberration was very imperfectly corrected.

Dr. Wallich briefly described his new condenser, which he exhibited in operation at the close of the meeting.

Mr. B. Piffard's new slide was exhibited and described by Mr. Crisp (*supra*, p. 655).

Mr. J. Mayall, jun., exhibited and described a simple mode of applying amplifiers to a Microscope (*supra*, p. 607). Several methods had been devised, and the one by Tolles was no doubt very good, but it was expensive. For the form which he now showed he did not claim any originality, because he remembered to have seen the same plan adopted, though in scarcely so simple a manner. His was simply a slide with three concave lenses, which could be pushed through the tube of the Microscope, so that either could be used as required. By this means the working distance could be increased by 75 per cent. The one to which he had referred had a rotating disk, and he thought

the straight slide was to be preferred, as it could be pushed higher or lower in the body-tube until the best position was found.

The President thought that so far as an amplifier was useful—and in many cases it *was* useful—the form which Mr. Mayall had exhibited was a good one.

Mr. Conrad Beck exhibited and described a new form of Microscope lamp (*supra*, p. 628).

The President thought that the lamp was most ingenious and satisfactory, and that many of the arrangements were such as would be of great utility to working microscopists.

Messrs. Swift's lamp, a cheaper form of the one shown at the March meeting, was also exhibited by Mr. J. Mayall, jun.

Mr. F. F. Hazlewood's note was read as to a human spermatozoon with two tails.

Dr. Anthony confirmed the statement that the occurrence of this variation from the normal type was not unprecedented.

Mr. J. Brennan's further communication on the Potato-blight Insect was read.

Mr. Cheshire described an organism which he exhibited, and which was identified by the President as a *Spirochæte*.

The President said the specimen showed considerable variation in the length and number of the spirals.

Mr. E. H. Griffith's new form of turntable was exhibited and described by Mr. Crisp.

Dr. Anthony read his paper "On Drawing Prisms," and illustrated the subject by numerous specimens of drawings of microscopic and other objects.

The President said the subject of Dr. Anthony's remarks was one of great practical importance to all who desired to make microscopical drawings correctly. He had used various forms himself, such as Wollaston's, Zeiss's, and Nachet's, though he thought he might say that he inclined towards the Wollaston, with which he had made his drawings of the flagellum of *Bacterium termo*. Although at the time he did not know why, he had found it quite necessary to tilt the drawing table in the way Dr. Anthony had described.

Mr. Crisp exhibited, in connection with Dr. Anthony's remarks, an ingeniously contrived drawing rest, which had been sent some time ago by the Geneva Physical Company, and which he thought met the want which Dr. Anthony had felt. It was an adaptation of the principle of the one figured at p. 565 of vol. iii. (1883) of the Journal.

The President said that when working he had a somewhat similar

arrangement made with a tripod on which the instrument was placed. For drawing he had a small table at the level of the stage mounted on a swivel, so that it could be used at any angle. He never worked below the level of the stage.

Mr. Michael said he had used the camera lucida a great deal in making drawings of all kinds, and his reason for rising was that it seemed to be taken for granted that Zeiss's form of camera was not so good as others. So far as his own experience and work were concerned, he had found it to be about the best, and he must confess that he did not see the image of the brasswork as had been described. His plan was very simple, for he used a drawing-board propped up upon books, so that the board was practically a continuation of the stage of the Microscope. If he thought that the image was not true he put in a stage micrometer and drew the image of it, and if this was done in two directions and both drawings were alike he knew that the projection was correct. As to the difficulty of seeing the pencil, he found that this varied very much with different persons, and that when he could not see it, others could do so with perfect distinctness. He liked to work with two lights and to have the light on the drawing-board much brighter than that in the Microscope; but on the other hand he found there were many persons who under these conditions would find that the image of the pencil overpowered the light from the object. He certainly thought the Zeiss form the best for ordinary mounted objects and for all such as were not mounted in fluid, whilst if it was desired to draw an object mounted in fluid there was nothing better for the purpose than the Nachet form. The camera lucida, it should always be remembered, was an instrument for drawing outlines rather than filling up details.

Mr. Beck said that the difficulties arising in connection with the camera lucida had from time to time come pretty prominently before him. There were two central forms which might be taken as types; one of these was the neutral tint reflector, and the other was the Wollaston. The neutral tint glass inverted the image so that a drawing made by it of anything which had the heart on the right side would be drawn as if it was on the left side. The practical difficulty met with in the use of the Wollaston camera was not because the Microscope had to be used in a horizontal position, but because of the difficulty experienced by some persons of seeing the point of the pencil. This might arise from the fact that very frequently persons used a large amount of light so that the pupil of the eye was very much contracted. He thought nothing could be better than the old Wollaston form; he had never himself found any difficulty in using it, and in spite of all the new contrivances which had been brought out, a large number of persons still used it and preferred it.

Mr. James Smith said that with regard to the difficulty which Mr. Beck had stated some people experienced in seeing the point of the pencil, the best plan was to cut a very fine point to the pencil, and then dip it into black ink, which would render it perfectly plain on the white paper. With regard to the adjustment of light, it would

be found that when making drawings by daylight it was a good plan to illuminate the object by the light of a small lamp, and to let the ordinary daylight fall upon the paper.

Mr. Dowdeswell's paper "On some Appearances in the Blood of Vertebrated Animals with reference to the occurrence of Bacteria therein," was read by him (*supra*, p. 525).

Prof. Bell said that Dr. Timothy Lewis who had been making some observations in India opened a dog and removed its two kidneys; one was placed directly into warm paraffin and left to cool, and the other was examined at once; the latter was found to contain no bacteria, but the one which had been put into the paraffin was found to be swarming with them. This fact had not been referred to by those who were at present examining into the nature of cholera germs, but he thought it contained a moral which applied to all forms of disease.

Mr. Beck considered the question to be an extremely interesting one. If what the Secretary had said—that the bacteria were the result and not the cause of the disease—was well founded, the same might apply to other diseases.

The President thought that it was not Mr. Dowdeswell's intention to say that there were disintegrated corpuscles, but that there were pseudo-bacteria. In the case of splenic fever the specific forms had been seen, and it had been not only proved that when introduced into the system they would give rise to the disease, but that when they had been filtered out the disease could not be so communicated, so that it was clear in this case that the bacteria were the absolute cause and not the result of the disease.

Dr. Anthony and the President further discussed the paper.

Mr. Oxley's paper "On *Protospongia pedicellata*, a New Compound Infusorian," was read by Prof. Bell (*supra*, p. 530).

Mr. C. D. Ahrens' paper "On a New Form of Polarizing Prism" (*supra*, p. 533) was, owing to the lateness of the hour, taken as read, Mr. Ahrens explaining briefly the principle of his arrangement by means of a black-board diagram.

The President said that at the last meeting of the Society it was mentioned that the American Society of Microscopists would hold their meeting at Rochester, N.Y., in August next, and he had been appointed, in connection with Mr. Glaisher and Mr. Bennett, to attend as representatives of the Society. Since then the American Association for the Advancement of Science had invited the Society to the meeting to be held at Philadelphia, and it had been proposed that the same gentlemen should attend that meeting also on behalf of the Society.

This proposal was approved unanimously.

Prof. Bell mentioned that the Victoria University of Canada had intimated their intention of conferring an honorary LL.D. degree upon their President during his visit to Canada, and he congratulated him on behalf of the Fellows on the honour thus proposed to be conferred.

The following Instruments, Objects, &c., were exhibited:—

Mr. Ahrens:—New Polarizing Prisms.

Dr. Anthony:—Prisms and drawings illustrating his paper.

Mr. C. Beck:—Microscope Lamp.

Mr. Cheshire:—Spirochæte.

Mr. Crisp:—(1) Zenger's Endomersion Objective; (2) Objective by Nobert, with curious form of correcting adjustment.

Mr. E. H. Griffith:—Turntable.

Mr. J. Mayall, jun.:—Microscope with sliding amplifiers.

Mr. Piffard:—New Slide.

Dr. Wallich:—Condenser.

New Fellows:—The following were elected *Ordinary* Fellows:—Messrs. T. Breeds, Arthur E. Davis, Ph.D., Robert Harwood, and James West; and Mrs. Catherine Crisp, the Hon. Mrs. Peek, and Mrs. Anne Wilson.

The Journal is issued on the second Wednesday of
February, April, June, August, October, and December.

Ser. II.
Vol. IV. Part 5. OCTOBER, 1884. {To Non-Fellows, Price 5s.

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

FRANK CRISP, LL.B., B.A.,

One of the Secretaries of the Society
and a Vice-President and Treasurer of the Linnean Society of London;

WITH THE ASSISTANCE OF THE PUBLICATION COMMITTEE AND

A. W. BENNETT, M.A., B.Sc., *Lecturer on Botany at St. Thomas's Hospital,* | F. JEFFREY BELL, M.A., *Professor of Comparative Anatomy in King's College,*

S. O. RIDLEY, M.A., *of the British Museum,* JOHN MAYALL, JUN.,
AND FRANK E. BEDDARD, M.A.,
FELLOWS OF THE SOCIETY.

WILLIAMS & NORGATE,
LONDON AND EDINBURGH.

PRINTED BY WM. CLOWES AND SONS, LIMITED,] [STAMFORD STREET AND CHARING CROSS.

CONTENTS.

SUMMARY OF CURRENT RESEARCHES, &c.—*continued.*

BOTANY.

SUMMARY OF CURRENT RESEARCHES, &c.—*continued.*

MICROSCOPY.

ROYAL MICROSCOPICAL SOCIETY.

COUNCIL.

ELECTED 13th FEBRUARY, 1884.

PRESIDENT.

Rev. W. H. Dallinger, F.R.S.

VICE-PRESIDENTS.

John Anthony, Esq., M.D., F.R.C.P.L.
Prof. P. Martin Duncan, M.B., F.R.S.
James Glaisher, Esq., F.R.S., F.R.A.S.
Charles Stewart, Esq., M.R.C.S., F.L.S.

TREASURER.

Lionel S. Beale, Esq., M.B., F.R.C.P., F.R.S.

SECRETARIES.

Frank Crisp, Esq., LL.B., B.A., V.P. & Treas. L.S.
Prof. F. Jeffrey Bell, M.A., F.Z.S.

Twelve other MEMBERS of COUNCIL.

Alfred William Bennett, Esq., M.A., B.Sc., F.L.S.
Robert Braithwaite, Esq., M.D., M.R.C.S., F.L.S.
G. F. Dowdeswell, Esq., M.A.
J. William Groves, Esq.
John E. Ingpen, Esq.
John Matthews, Esq., M.D.
John Mayall, Esq., Jun.
Albert D. Michael, Esq., F.L.S.
John Millar, Esq., L.R.C.P.Edin., F.L.S.
William Millar Ord, Esq., M.D., F.R.C.P.
Urban Pritchard, Esq., M.D.
William Thomas Suffolk, Esq.

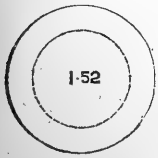
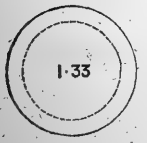
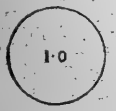
LIBRARIAN and ASSISTANT SECRETARY.

Mr. James West.

I. Numerical Aperture Table.

The "APERTURE" of an optical instrument indicates its greater or less capacity for receiving rays from the object and transmitting them to the image, and the aperture of a Microscope objective is therefore determined by the ratio between its focal length and the diameter of the emergent pencil at the plane of its emergence—that is, the utilized diameter of a single-lens objective or of the back lens of a compound objective.

This ratio is expressed for all media and in all cases by $n \sin u$, n being the refractive index of the medium and u the semi-angle of aperture. The value of $n \sin u$ for any particular case is the "*numerical aperture*" of the objective.

Diameters of the Back Lenses of various Dry and Immersion Objectives of the same Power (¼ in.) from 0·50 to 1·52 N A.	Numerical Aperture. ($n \sin u = a$.)	Angle of Aperture ($= 2u$). *Dry* Objectives. ($n = 1$.)	*Water-Immersion* Objectives. ($n = 1{\cdot}33$.)	*Homogeneous-Immersion* Objectives. ($n = 1{\cdot}52$.)	Illuminating Power. (a^2.)	Theoretical Resolving Power, in Lines to an Inch. ($\lambda = 0{\cdot}5269\ \mu$ = line E.)	Penetrating Power. $\left(\frac{1}{a}\right)$
	1·52	..	..	180° 0′	2·310	146,528	·658
	1·50	..	..	161° 23′	2·250	144,600	·667
	1·48	..	..	153° 39′	2·190	142,672	·676
	1·46	..	..	147° 42′	2·132	140,744	·685
	1·44	..	..	142° 40′	2·074	138,816	·694
	1·42	..	..	138° 12′	2·016	136,888	·704
	1·40	..	..	134° 10′	1·960	134,960	·714
	1·38	..	..	130° 26′	1·904	133,032	·725
	1·36	..	..	126° 57′	1·850	131,104	·735
	1·34	..	..	123° 40′	1·796	129,176	·746
	1·33	..	180° 0′	122° 6′	1·770	128,212	·752
	1·32	..	165° 56′	120° 33′	1·742	127,248	·758
	1·30	..	155° 38′	117° 34′	1·690	125,320	·769
	1·28	..	148° 28′	114° 44′	1·638	123,392	·781
	1·26	..	142° 39′	111° 59′	1·588	121,464	·794
	1·24	..	137° 36′	109° 20′	1·538	119,536	·806
	1·22	..	133° 4′	106° 45′	1·488	117,608	·820
	1·20	..	128° 55′	104° 15′	1·440	115,680	·833
	1·18	..	125° 3′	101° 50′	1·392	113,752	·847
	1·16	..	121° 26′	99° 29′	1·346	111,824	·862
	1·14	..	118° 00′	97° 11′	1·300	109,896	·877
	1·12	..	114° 44′	94° 56′	1·254	107,968	·893
	1·10	..	111° 36′	92° 43′	1·210	106,040	·909
	1·08	..	108° 36′	90° 33′	1·166	104,112	·926
	1·06	..	105° 42′	88° 26′	1·124	102,184	·943
	1·04	..	102° 53′	86° 21′	1·082	100,256	·962
	1·02	..	100° 10′	84° 18′	1·040	98,328	·980
	1·00	180° 0′	97° 31′	82° 17′	1·000	96,400	1·000
	0·98	157° 2′	94° 56′	80° 17′	·960	94,472	1·020
	0·96	147° 29′	92° 24′	78° 20′	·922	92,544	1·042
	0·94	140° 6′	89° 56′	76° 24′	·884	90,616	1·064
	0·92	133° 51′	87° 32′	74° 30′	·846	88,688	1·087
	0·90	128° 19′	85° 10′	72° 36′	·810	86,760	1·111
	0·88	123° 17′	82° 51′	70° 44′	·774	84,832	1·136
	0·86	118° 38′	80° 34′	68° 54′	·740	82,904	1·163
	0·84	114° 17′	78° 20′	67° 6′	·706	80,976	1·190
	0·82	110° 10′	76° 8′	65° 18′	·672	79,048	1·220
	0·80	106° 16′	73° 58′	63° 31′	·640	77,120	1·250
	0·78	102° 31′	71° 49′	61° 45′	·608	75,192	1·282
	0·76	98° 56′	69° 42′	60° 0′	·578	73,264	1·316
	0·74	95° 28′	67° 36′	58° 16′	·548	71,336	1·351
	0·72	92° 6′	65° 32′	56° 32′	·518	69,408	1·389
	0·70	88° 51′	63° 31′	54° 50′	·490	67,480	1·429
	0·68	85° 41′	61° 30′	53° 9′	·462	65,552	1·471
	0·66	82° 36′	59° 30′	51° 28′	·436	63,624	1·515
	0·64	79° 35′	57° 31′	49° 48′	·410	61,696	1·562
	0·62	76° 38′	55° 34′	48° 9′	·384	59,768	1·613
	0·60	73° 44′	53° 38′	46° 30′	·360	57,840	1·667
	0·58	70° 54′	51° 42′	44° 51′	·336	55,912	1·724
	0·56	68° 6′	49° 48′	43° 14′	·314	53,984	1·786
	0·54	65° 22′	47° 54′	41° 37′	·292	52,056	1·852
	0·52	62° 40′	46° 2′	40° 0′	·270	50,128	1·923
	0·50	60° 0′	44° 10′	38° 24′	·250	48,200	2·000

EXAMPLE.—The apertures of four objectives, two of which are dry, one water-immersion, and one oil-immersion, would be compared on the *angular* aperture view as follows:—106° (air), 157° (air), 142° (water), 130° (oil).
Their actual apertures are, however, as ·80 ·98 1·26 1·38 or their numerical apertures.

II. Conversion of British and Metric Measures.

(1.) Lineal.

Scale showing the relation of Millimetres, &c., to Inches.

1000 μ = 1 mm.
10 mm. = 1 cm.
10 cm. = 1 dm.
10 dm. = 1 metre.

Micromillimetres, &c., into Inches, &c.

μ	ins.	mm.	ins.	mm.	ins.
1	·000039	1	·039370	51	2·007892
2	·000079	2	·078741	52	2·047262
3	·000118	3	·118111	53	2·086633
4	·000157	4	·157482	54	2·126003
5	·000197	5	·196852	55	2·165374
6	·000236	6	·236223	56	2·204744
7	·000276	7	·275593	57	2·244115
8	·000315	8	·314963	58	2·283485
9	·000354	9	·354334	59	2·322855
10	·000394	10 (1 cm.)	·393704	60 (6 cm.)	2·362226
11	·000433	11	·433075	61	2·401596
12	·000472	12	·472445	62	2·440967
13	·000512	13	·511816	63	2·480337
14	·000551	14	551186	64	2·519708
15	·000591	15	·590556	65	2·559078
16	·000630	16	·629927	66	2·598449
17	·000669	17	·669297	67	2·637819
18	·000709	18	·708668	68	2·677189
19	·000748	19	·748038	69	2·716560
20	·000787	20 (2 cm.)	·787409	70 (7 cm.)	2·755930
21	·000827	21	·826779	71	2·795301
22	·000866	22	·866150	72	2·834671
23	·000906	23	·905520	73	2·874042
24	·000945	24	·944890	74	2·913412
25	·000984	25	·984261	75	2·952782
26	·001024	26	1·023631	76	2·992153
27	·001063	27	1·063002	77	3·031523
28	·001102	28	1·102372	78	3·070894
29	·001142	29	1·141743	79	3·110264
30	·001181	30 (3 cm.)	1·181113	80 (8 cm.)	3·149635
31	·001220	31	1·220483	81	3·189005
32	·001260	32	1·259854	82	3·228375
33	·001299	33	1·299224	83	3·267746
34	·001339	34	1·338595	84	3·307116
35	·001378	35	1·377965	85	3·346487
36	·001417	36	1·417336	86	3·385857
37	·001457	37	1·456706	87	3·425228
38	·001496	38	1·496076	88	3·464598
39	·001595	39	1·535447	89	3·503968
40	·001575	40 (4 cm.)	1·574817	90 (9 cm.)	3·543339
41	·001614	41	1·614188	91	3·582709
42	·001654	42	1·653558	92	3·622080
43	·001693	43	1·692929	93	3·661450
44	·001732	44	1·732299	94	3·700820
45	·001772	45	1·771669	95	3·740191
46	·001811	46	1·811040	96	3·779561
47	·001850	47	1·850410	97	3·818932
48	·001890	48	1·889781	98	3·858302
49	·001929	49	1·929151	99	3·897673
50	·001969	50 (5 cm.)	1·968522	100 (10 cm. = 1 decim.)	
60	·002362				
70	·002756				
80	·003150				
90	·003543				
100	·003937				
200	·007874				
300	·011811				
400	·015748				
500	·019685				
600	·023622				
700	·027559				
800	·031496				
900	·035433				
1000 (= 1 mm.)					

decim.	ins.
1	3·937043
2	7·874086
3	11·811130
4	15·748173
5	19·685216
6	23·622259
7	27·559302
8	31·496346
9	35·433389
10 (1 metre)	39·370432
=	3·280869 ft.
=	1·093623 yds.

Inches, &c., into Micromillimetres, &c.

ins.	μ
1/25000	1·015991
1/20000	1·269989
1/15000	1·693318
1/10000	2·539977
1/9000	2·822197
1/8000	3·174972
1/7000	3·628539
1/6000	4·233295
1/5000	5·079954
1/4000	6·349943
1/3000	8·466591
1/2000	12·699886
1/1000	25·399772
	mm.
1/900	·028222
1/800	·031750
1/700	·036285
1/600	·042333
1/500	·050800
1/450	·056444
1/400	·063499
1/350	·072571
1/300	·084666
1/250	·101599
1/200	·126999
1/150	·169332
1/100	·253998
1/50	·507995
1/25	1·015991
1/20	1·269989
1/16	1·587486
1/15	1·693318
1/12	2·116648
1/10	2·539977
1/8	3·174972
1/6	4·233295
3/16	4·762457
1/5	5·079954
1/4	6·349943
5/16	7·937429
3/8	9·524915
	cm.
7/16	1·111240
1/2	1·269989
9/16	1·428737
5/8	1·587486
11/16	1·746234
3/4	1·904983
13/16	2·063732
7/8	2·222480
15/16	2·381229
1	2·539977
2	5·079954
3	7·619932
	decim.
4	1·015991
5	1·269989
6	1·523986
7	1·777984
8	2·031982
9	2·285979
10	2·539977
11	2·793975
1 ft.	3·047973
	metres.
1 yd. =	·914392

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

FRANK CRISP, LL.B., B.A.,

one of the Secretaries of the Society and a Vice-President and Treasurer of the Linnean Society of London;

WITH THE ASSISTANCE OF THE PUBLICATION COMMITTEE AND

A. W. BENNETT, M.A., B.Sc., Lecturer on Botany at St. Thomas's Hospital,

F. JEFFREY BELL, M.A., Professor of Comparative Anatomy in King's College,

S. O. RIDLEY, M.A., of the British Museum, JOHN MAYALL, Jun., and FRANK E. BEDDARD, M.A.

FELLOWS OF THE SOCIETY.

THIS Journal is published bi-monthly, on the second Wednesday of the months of February, April, June, August, October, and December. It varies in size, according to convenience, but does not contain less than 9 sheets (144 pp.) with Plates and Woodcuts as required. The price to non-Fellows is 5*s.* per Number.

The Journal comprises:

(1.) The TRANSACTIONS and the PROCEEDINGS of the Society: being the Papers read and Reports of the business transacted at the Meetings of the Society, including any observations or discussions on the subjects brought forward.

(2.) SUMMARY of CURRENT RESEARCHES relating to ZOOLOGY and BOTANY (principally Invertebrata and Cryptogamia, with the Embryology and Histology of the higher Animals and Plants), and MICROSCOPY (properly so called): being abstracts of or extracts from the more important of the articles relating to the above subjects contained in the various British and Foreign Journals, Transactions, &c., from time to time added to the Library.

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 12*s.* 6*d.* per half-sheet of 8 pages, or less, including cover, for a minimum number of 100 copies, and 6*s.* per 100 plates, if plain. Prepayment by P.O.O. is requested.

All communications as to the Journal should be addressed to the Editor, Royal Microscopical Society, King's College, Strand, W.C.

Published for the Society by

WILLIAMS AND NORGATE,

LONDON AND EDINBURGH.

MICROSCOPICAL SOCIETY'S TRANSACTIONS (3 vols., half-calf); QUARTERLY JOURNAL OF MICROSCOPICAL SCIENCE (16 vols., half-morocco); and MONTHLY MICROSCOPICAL JOURNAL (18 vols., half-calf) for SALE. Price £20.

Apply to Mr. J. WEST, at the Society's Library.

ROYAL MICROSCOPICAL SOCIETY.

MEETINGS FOR 1884, at 8 p.m.

Wednesday, JANUARY	9	Wednesday, MAY	14
„ FEBRUARY	13	„ JUNE	11
(*Annual Meeting for Election of Officers and Council.*)		„ OCTOBER	8
„ MARCH	12	„ NOVEMBER	12
„ APRIL	9	„ DECEMBER	10

THE "SOCIETY" STANDARD SCREW.

The Council have made arrangements for a further supply of Gauges and Screw-tools for the "SOCIETY" STANDARD SCREW for OBJECTIVES.

The price of the set (consisting of Gauge and pair of Screw-tools) is 12*s.* 6*d.* (post free 12*s.* 10*d.*). Applications for sets should be made to the Assistant-Secretary.

For an explanation of the intended use of the gauge, see Journal of the Society, I. (1881) pp. 548–9.

THE BRITISH MOSS FLORA.

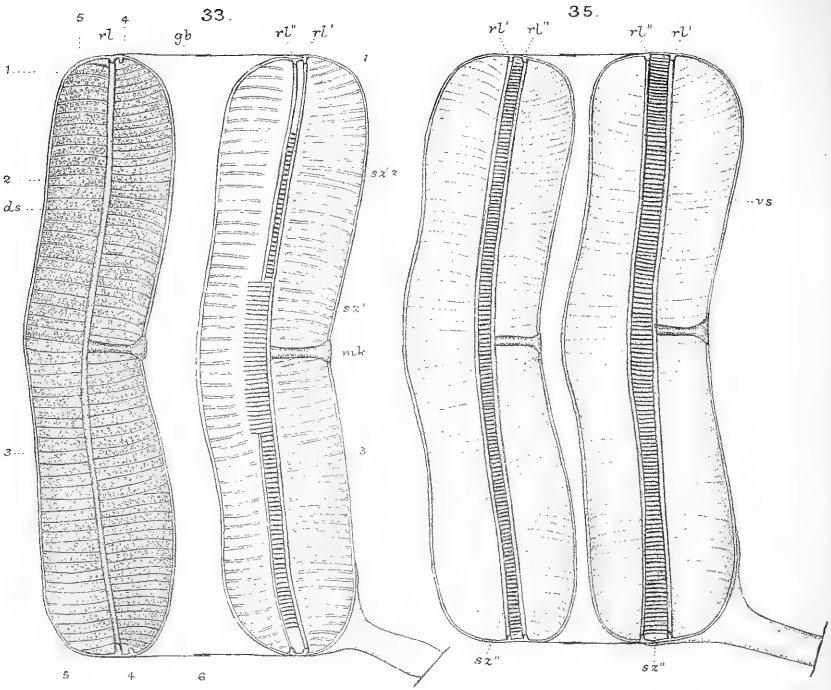
By R. BRAITHWAITE, M.D.

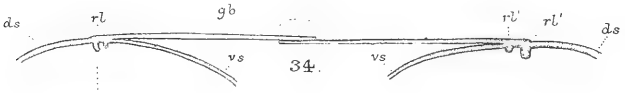
PART VIII., TORTULACÆ, is now ready, price 6*s.* Subscriptions to Sect. 3 (10*s.* 6*d.*) may be sent to the Author.

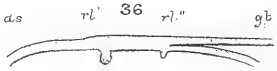
The previous Parts may be had from the Author, at 303, Clapham Road, London.

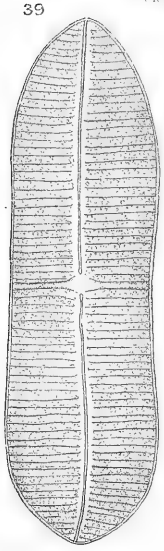
ADVERTISEMENTS FOR THE JOURNAL.

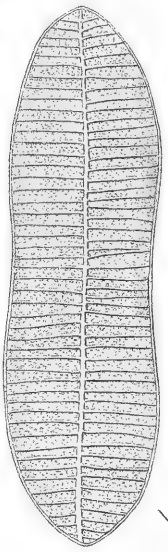
Mr. CHARLES BLENCOWE, of 75, Chancery Lane, W.C., is the authorized Agent and Collector for Advertising Accounts on behalf of the Society.

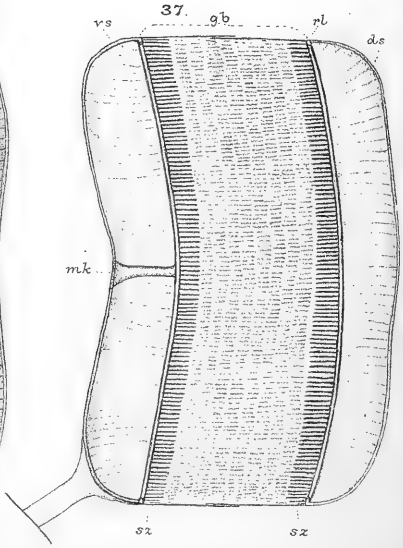








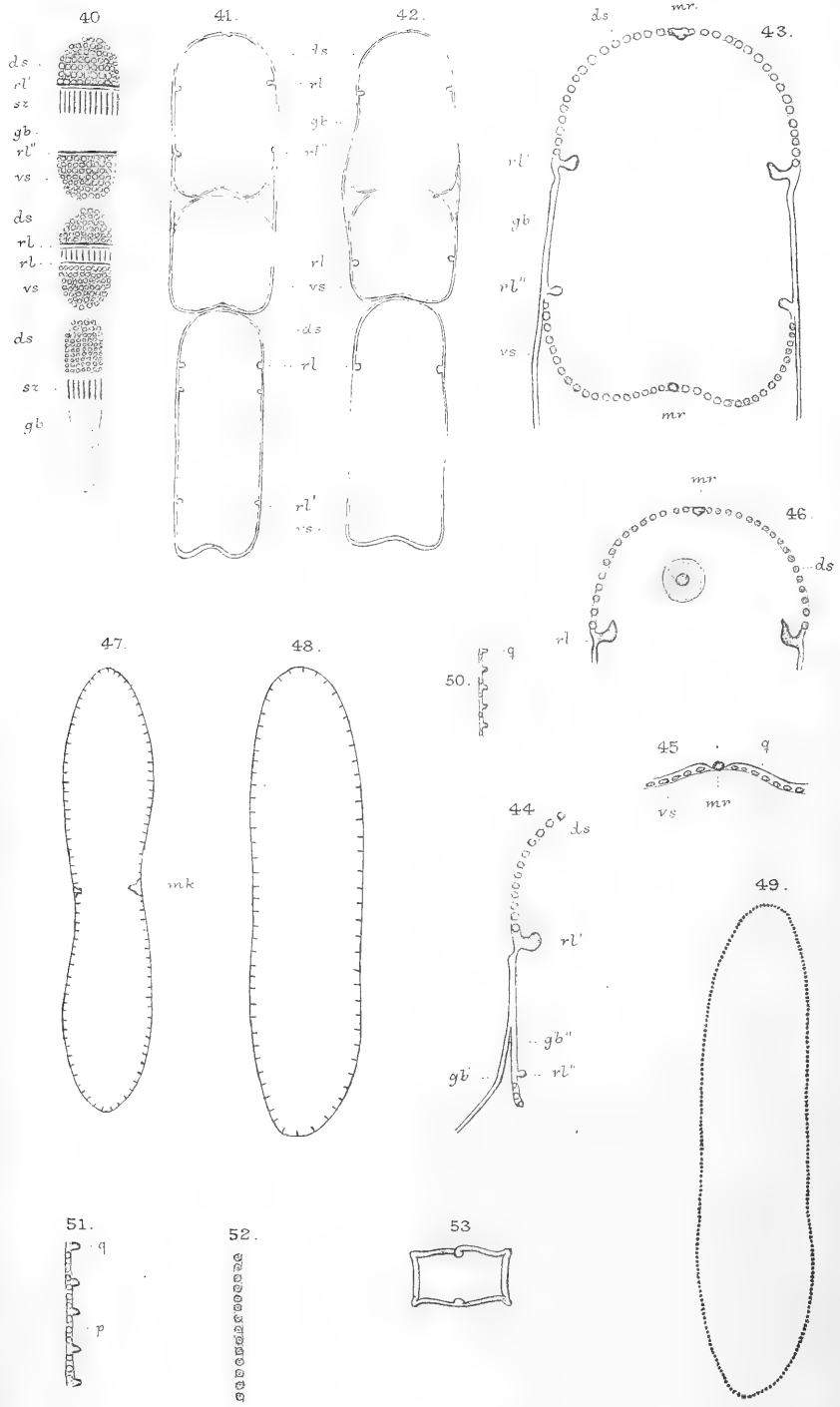




J.H.L. Flögel del.

West, Newman & Co imp.

Achnanthes.



J.H.L.Flögel del. West, Newman & C° lith.

Achnanthes.

JOURNAL

OF THE

ROYAL MICROSCOPICAL SOCIETY.

OCTOBER 1884.

TRANSACTIONS OF THE SOCIETY.

XVI.—*Researches on the Structure of the Cell-walls of Diatoms.** (*Continued.*)

By Dr. J. H. L. Flögel.

(*Read 12th December*, 1883.)

Plates IX., X., and XI.

5. *Triceratium.*

The old attempts to explain the sculpture of this group may be passed over, also Prof. A. Weiss's work of 1871 (28), since we have a very good paper by O. Müller on *Triceratium favus* Ehrenb. (15), which elucidates the entire sculpture of the valve in a most satisfactory manner. I might therefore omit my investigation of *T. favus*, the only species I examined, the more so as I have generally only to confirm Müller's results. As, however, *Triceratium* is taken as the type for diatom sculpture generally, and because in minor points I arrived at somewhat different results, I prefer not to suppress my investigations which were made from sections (serial preparations) and casts. The material was presented to me by Herr Möller, of Wedel.

The production of sections perpendicular to the surface of the membrane is a comparatively easy task. The large triangle can be readily seen in the gum, and the knife guided accordingly. Series of 15–20 sections can be made without difficulty.

We have, as Müller correctly describes, a thin basal membrane adjoining the cell-lumen, and apparently quite smooth. On the outer surface is a system of ordinary network mostly representing hexagonal spaces, which are vertical chamber-walls. Above, these lines extend to almost horizontal walls, leaving, however, for each of these chambers a large round central opening. Each of the

* The original paper is written in German, and has been translated by Mr. J. Mayall, jun.

hexagonal cells observed in the surface view is therefore a chamber in the shape of an hexagonal prism; only the base of the same, the outer surface, is not complete, but has the well-known and often-described circular opening. On the vertical walls—namely, the side faces of the prisms—in the corners of every third chamber is a spine. If the thicknesses of these fine membranes are to be measured, very choice sections must be taken. The basal membrane has a very fine sculpture as illustrated by Weiss, but much better and more accurately given by Müller. It consists of a system of fine dots, radiating in lines from the central space of the entire valve, and of which 60–80 are contained in an hexagonal cell. Only on the finest sections with the highest power one catches a glimpse of these points. I cannot say that the line would thus be seen distinctly beaded; and equally invisible are the points adhering at the inner side only of the basal membrane, as Müller represents it in transverse section (his fig. 11). Possibly these are also chamber-like cavities, as with *Pleurosigma*. The definition will be very difficult, but possibly casts will help us hereafter.

We have still to consider the margin of the valve and the three horn-like protuberances. Müller has spoken of these explicitly, but I find some variations. With regard to configuration of the margin, Müller gives correctly (his fig. 9) the view of the surface of the marginal line. The transverse section (his fig. 11 *d*) represents this line too much bent inwards. I have therefore given a diagram, plate IX. fig. 21, of one of my transverse sections. The line is nearly vertical to the membrane surface and is slightly broader at the top, not pointed. The three protuberances at the three corners of the triangle have been correctly rendered by Müller; but everybody who has not seen them in sections will find it difficult to realize them in his figs. 6 and 7, because they exhibit too much of other detail and shadow. For this reason I give the diagram of a true vertical section of such a protuberance, fig. 22. According to Müller, these protuberances might possibly be open at the point, for which I have not found the slightest justification. Nor is his cited example of *Eupodiscus* a proof, in my estimation, because I see the points in this group also closed.

The method of collodion casts confirms in general the results obtained by the section method. The collodion enters through the outer larger opening into the chamber, and leaves on the surface of the dry cast a somewhat round mass which has very little likeness to the beautiful regular prism of the chamber. On closer examination one distinguishes these spines in the cast as distinct depressions in the corners between the masses. The cast of the inner side of a valve is perfectly smooth. I could not succeed in obtaining a cast of the delicate porous structure, either because it does not exist or because the collodion used showed reticulation in hardening.

6. *Coscinodiscus.*

Of this species I have examined four varieties. I collected the material myself on the Norwegian coast, and another portion was from the 'Pomerania' expedition (9).

§ 1. *Coscinodiscus radiatus* Ehrenb.—This species gave the best results, because the chambers are of considerable size, and I had a sufficient quantity of them. Among the specimens obtained with the knife one is especially interesting, because it was obtained during fission. This is represented in fig. 31. I photographed a particularly successful section as a type-image. This section is very good, but for the study of the sculpture a little too thick; for this reason I have delineated in fig. 23 the marginal portion of an adjoining fine section under very high magnification. From both images the sculpture of this species may be deduced as follows:—The general form of *C. radiatus* is a very thin disk like a coin; both faces are circular and display the pretty delicate areolæ. Vertical sections through the disk give everywhere the same image, the central one included. The cell-wall of these disks consists of a very thin basal membrane, having on the outside very delicate but prominent network. This network is enlarged and thickened at the end, and so much enlarged that the lines almost coalesce. In inferior sections one sees a continuous outline, which is divided from the inner membrane by bars, but in very good sections the lines have the shape of a T. In consequence the network forms prismatic chambers, mostly hexagonal, but also five-sided and four-sided, which without doubt must have an opening from the outside, even if it be very small. In the surface view I did not observe this opening until after my attention had been drawn to it by the sections. It is seen with balsamed preparations like a small nodule, having 1/4 to 1/3 of the diameter of an areola, and in superficial examination it may easily be mistaken for the focal image of a chamber. To decide this point search must be made above the acute portion of the chamber-walls. The large number I examined of good sections which all agree when thin enough, and show no continuous outline, prove definitely the existence of a small opening. The opening, in proportion to the size of the chamber, is smaller than the circular opening of the *Triceratium* chamber, as may be seen from the diameter of the chamber-walls, which have a somewhat different shape from *Triceratium*. Otherwise they are both very similar, but *Coscinodiscus* has no spines; the outer surface is therefore smooth. The height of the chamber is equal to its breadth (3–$3 \cdot 2\,\mu$). Towards the edge of the disk both dimensions decrease. The girdle-band is seen in most of the sections; it is without sculpture. Regarding its connection with the two inner newly formed cell-

walls several results were obtained with the sections. These two new disks have the same sculpture as the two of the outer valves, except that all outlines are much finer, and the chambers are also not exactly of the same definite height. One observes that the chamber-walls in the two young disks sometimes touch each other, sometimes not. The manner in which all these parts are connected with one another is very peculiar. I must here refer to what I say further on about *Achnanthes*. With *Coscinodiscus* there is no doubt that at least the one of the two newly formed cells is completely closed outwards. The basal membrane of the one outer valve goes continuously in equidistant curves into the basal membrane of the corresponding inner valve; at the bend a few delicate lines are seen which are the sections of the walls of the considerably reduced marginal chambers. Out of this portion the new girdle-band must be developed, as hitherto it has not been detected. One observes in the other newly formed cell (the lower one in the fig.) existing in all central sections a break, which the membrane of the new valve makes at the bend, and this gives the appearance as if the basal membrane of the old valve was continued here directly in the inclosed girdle-band, which is probably the case; but one also observes here a break. Nevertheless I believe that this second cell is closed at the bend of the membrane, a conviction to be gained only by very careful study of the entire section series. Future investigators who will work with patience have an inexhaustible field before them; they will have to turn their attention specially to the gradual development of the chamber-walls and determine whether, for example, as Müller indicates for *Triceratium*, network arises from a basal membrane at first smooth, or whether it is more probable that at first hollows are developed in the membrane which afterwards become chambers open at the top. It is interesting to see in this fission specimen how, during the process of division, the lumen of both cells was reduced almost to nothing, and very nearly the entire inner space of the former mother-cell was filled up with the substance of the two new walls. A coalescing of the two disks during the imbedding in gum cannot be entertained, inasmuch as they would show cracks at the edge, as old valves are unusually brittle. If we compare with this an ordinary undivided specimen, from one of which I have given a nearly median section out of the marginal portion, fig. 24, the difference is at once apparent. In other respects such a section displays very little variation from the above representation. The first section through the same specimen, which shows the girdle-band of the surface and the minute chambers in the convex edge, is given in fig. 25. I could not obtain collodion casts of any service, nor could I succeed in fixing permanently colouring matters in the spaces of the chambers. If the latter

could be accomplished with not wholly soluble but only suspended colours a further clear proof would be furnished of the existence of the openings of the chambers. Fossil specimens of *Coscinodiscus radiatus* from marl slate from Oran, for which I have to thank Prof. Dippel, appear in their section-images quite in harmony with the above. As a matter of course here is no longer cellulose, and the valves and the girdle-bands are isolated. In the surface-image the opening to the chamber is a little larger than with the other specimens, which may be attributed to the loss of the cellulose. Putting the outer surface (for instance, line 1, fig. 23) under a high power we see these openings as delineated in fig. 26. By slightly raising the slide so that line 2 is seen, the inner ring disappears and distinct chamber-walls are seen, fig. 27. One estimates the thickness of these walls in the surface-image too high, a circumstance connected either with the magnification of the outer marginal thickening of these walls, or which must be explained by the reflection of the light from the walls.*

In a few specimens, not far from the edge, I observe unusually large chamber-walls, fig. 28; the cavity is apparently quite spherical, and only at some distance off does it take the prismatic form. It seems to me quite unimaginable that the membrane should have raised itself as an annular wall until quite above or nearly so, and then have closed itself again over such a cavity (the pointed shaped opening seems really sometimes to be wanting altogether); and for this second reason in support of my former conjecture—according to which the cavities develop and enlarge themselves in the substance of the walls, and in this case open by the resorption of the girdle—I give preference to my explanation rather than to Müller's.

§ 2. *C. Oculus iridis* Ehrenb.—The works of Slack, Stephenson, and Morehouse relating to this species (25, 26, and 13), I know only through Just's 'Jahresbericht.' According to Pfitzer's reference, Stephenson describes an outer layer of deep hexagonal cells which are one and a half times as deep as broad, and which, judging from the positive images which they give of outer objects, are either open on both sides or closed by nearly plane membranes. The latter becomes more probable through the appearance of small depressions in the base of the cells, the edge of which is undulated. The inner layer Stephenson describes as a thin hexagonal areola

* On this subject compare my work on *Pleurosigma*, p. 507, where the reflection appearances within vertical chamber walls are fully discussed. With a stage having an opening covered by a glass plate which is slightly tilted these experiments can be controlled. Since outwards of the edge-line of a wall black always appears first and white within, it becomes evident that with small dimensions an apparent thickening of such vertical membranes must always result, because the eye naturally takes the middle of the black line as the limit.

plate having a spherical opening in the centre of each hexagon. Slack asserts he has seen real depressions and a real projecting network, both composed of small spherules. Morehouse sees duplex valves, the inner of which has spherical openings, the edges representing the thickest parts of the valve; the hexagonal network of the outer valve lies in the depressions between those edges. Across the mesh of the network extends a thin siliceous film with most delicate anastomosing network, having its weakest point in the centre. All sorts of things may be observed on this object if one remains satisfied with a mere examination of the surface. The nearest approach to the real state of affairs was made in 1880 by Prinz (21). His figs. 7 and 8 represent tolerably well the vertical chamber-walls, although by the method applied (the experiments were made with thin rock sections) the real details would be difficult to make out. This species viewed on the surface is to be distinguished by the large areola in the centre of the disk; the section shows that the entire cell has no longer the form of a coin, but, in consequence of the slight curving of the disk, is like a bi-convex lens. The areolæ are slightly smaller than those of *C. radiatus*. My somewhat numerous sections through one specimen are very similar to those of *C. radiatus*, but I find nowhere a definite clue for the existence of an outer opening. In fig. 29 a small portion of a vertical section is given to the right, as observed with most of the sections; on the left are seen small portions in the edge of fine slightly injured sections. Here I am in doubt whether the T-shaped figures may not be produced by the splitting of the very fine outer membranes which are in the girdle; if everything in the gum is uninjured one sees the membrane extending evenly across the supports without indication of holes. It is curious that with this species very often an air-bubble remains behind in the chambers which hardly ever occurs with *C. radiatus* and *Pinnularia*, and this might suggest that the fluid gum does not enter through openings but in the more difficult endosmotic process. It is unnecessary to deal more in detail with the statements of Stephenson and Slack. The former has apparently arrived at his view through examining a specimen in process of fission.

§ 3. *C. centralis* Ehrenb.—This is a very large species, of 1/3 mm. in diameter, strongly convex, having in the centre a few large areolæ. I have before me a number of sections through a valve which had unusually coarse markings, thus differing but slightly from *C. radiatus*. Fig. 30 is a portion of one of the best sections, and shows the chambers with the T-shaped sections of the walls, suggesting arches; the surface view is like *C. radiatus*. Here also no opening can be detected in the finest edge-portions, therefore I believe I am accurate in stating that this species has completely closed chambers. One must not be led away by the

marginal shadows which give the above strongly thickened T lines. A close examination confirms the existence of a very fine line between them. Hence we have here two distinct membranes connected by a system of mesh-like walls. The walls commence at the inner membrane very thin, and gradually become thicker as they approach the outer membrane, so that they appear wedge-like in the section. Similarly the adhesion point at the outer membrane is thickened, and this thickening gradually diminishes over the centre of the chamber. The outer surface of the outer membrane is uncommonly even, so much so, that in a dry condition the valve reflects light as strongly as a mirror. This fact alone cannot be reconciled with the idea of openings (*C. radiatus* does not reflect as a mirror), anyhow the openings could not be estimated at more than 1/8 or 1/10 of the chamber diameter in order not to interfere with the smoothness of the membrane. Collodion casts would be very desirable in the investigation of this species. The dots of the areolæ in the surface view, formerly described and figured by me (9, p. 86, fig. 6), cannot be seen in the sections.

§ 4. *C. concinnus* W. Smith.—This species is much larger and more delicately enveloped than the former, about 0·5 mm. in diameter and equally convex. The section of a valve of a not very large but very finely marked specimen, fig. 31, shows the familiar image of chambers closed on all sides, such as I demonstrated by my *Pleurosigma* investigations, except that with this *Coscinodiscus* they are considerably larger (about 1 μ). The valve reflects light strongly. For the surface view I refer to my former notices and figs. (9, p. 86, fig. 5). After the investigation of these four varieties I believe that in the species of *Coscinodiscus* we have before us the gradual transition from the *Triceratium* type to the *Pleurosigma* type, inasmuch as the small outer opening of the chamber which is still seen in a few varieties, totally disappears in others.

7. *Isthmia.*

It is not at all difficult to cut this giant amongst the diatoms, but it is very difficult to obtain sections of the requisite degree of fineness. The cell-wall is everywhere of unusual delicacy. After examining some forty-five sections I am enabled to give the following description of the cell-wall:—

There is a difference between that portion of the frustule which corresponds to the valves, viz. the sloping ends of the rhomboidal cell, and the middle portion, which is to be regarded as the girdle-band and under which the division takes place. This difference is marked outwards by a strong expression of the areolæ in the end portions in contrast to the delicate markings of small cells in the girdle. With the sections one must always endeavour to determine

to which part the portion belongs which is under examination. In order not to err on this point I have kept to the pointed ends in the investigation of the valves, and which exhibit in the section comparatively very small rings. Photograph 19 illustrates a section through two frustules and through one connecting end being the isthmus proper. The small ring, without doubt the valve, shows on the inner side distinct projections, that is to say, wall-thicknesses apparently vanishing like network produce the cell-figure in the surface view. The membrane at the non-thickened end, that is to say, at the lumen of the pseudo-cells, is of extreme thinness. The immediately preceding much finer section corroborates still more what I say. The thickness of the wall is about $0 \cdot 3\ \mu$, and in the net projections $1 \cdot 2\ \mu$, we thus obtain an image of simple inner cell-envelope thickenings in a manner leaving nothing to be desired, and which has not the slightest similarity to *Triceratium*. The cell-wall of the middle girdle differs inasmuch as the thickening lines producing the markings are undoubtedly on the outer side. The wall-thickness is so extraordinarily small that with a magnification of 1000 it appears only as a mere line. The net-lines are also very flat, about $0 \cdot 7\ \mu$ in height. With reference to the girdle-band one can speak with full conviction of a surface-sculpture, whilst with the valves one must say inner surface-sculpture. Here may be added that *Isthmia* has a large cell-nucleus lying in the inner granular protoplasm, and which was touched by me several times in my sections. It is a spherical transparent vesicle of $16\ \mu$ diameter, having a spherical nucleolus of $4 \cdot 5\ \mu$ in diameter. The result obtained from surface views of dry imbedded *Isthmiæ* does not at all agree with that obtained with the transverse section images; the thickening lines appear like strong refracting masses, and were looked upon as such by the earliest investigators (Ehrenberg, Kützing, and others). It was not at all to be expected from an *à priori* examination that the sculpture of this species would appear so totally different from *Triceratium*. I shall not be expected to enter further into the researches of Slack (25), according to whom the membrane consists of small spheres.

8. *Achnanthes.*

If an obstinate defender of the opinion that diatom sculpture consists of inner cell-wall thickenings, wishes to secure an object substantiating his view, I can very strongly recommend to him the large forms of *Achnanthes*. After having occupied myself inland for years with fresh-water diatoms, on meeting with the marine *Achnanthes* I believed I had found the long-searched-for proof. Each surface view under a good Microscope shows clearly the

projection of lines on the inner side of the membrane, whilst the outer side is perfectly smooth. It can be seen more distinctly in sections, but in proceeding we shall soon have to admit that a part of what we stated has to be reconsidered. The following relates only to *Achnanthes brevipes* Ag.*

§ 1. We have to distinguish three sorts of markings in *Achnanthes*. This diatom has an unsymmetrical shape at the division-plane, so that only the two middle sections vertical to this plane give symmetrical halves. Therefore we get:—(1) A dorsal valve characterized by greater convexity; it has a mid-rib without nodule running evenly from one end to the other; close to it run the smooth transverse lines, the interspaces of which are wider than those of the ventral valve; between every pair of transverse lines are seen in most instances three rows of dots, sometimes only two. (2) A ventral valve, characterized by a thick depression in the middle; it has a mid-rib with even striæ on both sides, in the centre a large nodule which at right angles to the mid-rib extends to the edge, thereby producing, the same as with *Stauroneis*, the image of a cross. The transverse lines are finer than in the dorsal valve; between each pair, as a rule, one row of dots, sometimes two. (3) The girdle-band, always with delicate striæ vertical to the division-plane, which however is subject to variations as we shall presently see. The figs. 33, 37, 38, and 39, plate X., of *A. brevipes* sufficiently illustrate this description.

Two good serial sections are obtained, running vertical to the division-plane and to the two mid-ribs (in fig. 33 this is delineated by lines 1–3); the third series I made approximately parallel to the division-plane. My attempts in the third direction of space (the horizontal) failed. From one of the two former series, numbering twenty-three sections, I have delineated three, viz. 1, 5, and 15, figs. 40–2, plate XI. No. 1 is a marginal cut; 23 has nearly the same appearance. No. 15 cannot be far from the middle, because among the succeeding numbers are a few of too great thickness.

Examining first the general form, we see from the sections in which all three conform, that the ventral valve is depressed, trough-like, along the mid-rib, whilst the dorsal valve appears half-cylindrical, that is to say, rounded off convexly. By this feature

* The difference between *A. brevipes* and *longipes* Ag. is often very great. *A. longipes* commences with a short pedicle; the pointing or rounding of the valves is somewhat variable, and the distance between the striæ is not always definite. From the stria distances and the length of the pedicle, I believe I have determined the specimens investigated to be *A. brevipes*, but they might belong to *A. longipes*. The specimen figured by Pfitzer as *A. brevipes* (19, pl. vi. fig. 15 *s*) I should rather suppose to be *A. ventricosa* Ktz.; anyhow, this variety is not the one investigated by me under the name of *A. brevipes*. I have found *A. ventricosa* on the sea-shore near Sylt, but could not make use of it in the present investigation (*vide* 5, p. 737).

we are able to distinguish either valve even with imperfect sections. The convexity of the dorsal valve fits nearly into the trough of the ventral valve, so that they touch each other when of large size. The section-bundle consisted of three frustules, of which the lowest was probably near the period of its second division, whilst the other two had only recently emerged, therefore the lowest, compared with the others, is probably backward in development. The girdle-band comprises only the limit-line between the lowest and middle frustule. With reference to the fine sculpture, mention must be made of a portion of membrane hitherto unobserved, and which could not have been well detected without transverse sections. This is the projection on the edge of each valve, that is to say, at the limit between valve and girdle-band, a spine turning far inwards as shown in the figs. (*r l*), and is found fourfold in each frustule. All sections of the two series prove clearly these four projections; they can only be the expression of a projecting line running along the edge towards the inner space of the cell, I will call it edge-line, which with the usual division of the frustule plays a prominent part as we shall see. With low powers one sees only the four small spines; applying the highest power one observes that the larger spines, at any rate, are hook-shaped towards the valve-cavity, fig. 43; it may actually become a hook, fig. 46. The end-valves, being the oldest in the row, have the largest hooks and the strongest edge-line. In the youngest valves one sees the partially developed hooks, sometimes hardly nodule-shaped, fig. 44.

The largest hooks penetrate 2 μ into the cavity of the cell. After having discovered the marginal lines in the sections it became easy to trace them again in the surface view; they are particularly well seen in balsam preparations (in consequence of the weaker refraction of the walls). The older investigators, for instance, Kützing (plate 20, IX., 1) and Ehrenberg, figure distinct dark marginal lines ending with a nodule. The transversely cut marginal line is in section far more conspicuous than the mid-ribs; in most instances one sees the mid-ribs as round nodules standing off the membrane; occasionally they may be seen somewhat more distinctly. Altogether the dimensions are very small, and only in the most favourable instances can one determine that they project inwards and not outwards. The valve surfaces are always seen in good sections as distinct rows of dots, pearl-like, and this is the expression of the fine dots of which I spoke above. These pearls I declare to be, according to the best and most reliable sections, chambers closed on all sides situated within the membrane. The direction of the cuts in the series in question being parallel with the actual transverse striæ, one can hardly expect to discover anything about the condition of the latter. But if the section is very thin, one sees on the inner side of the pearl row a fine straight line depressed

at the mid-rib, fig. 45, so that at the side of it are two thin membrane-striæ free from dots, such as we demonstrated in the surface-image. This fine line I consider to be the limit of the inward projecting transverse striæ, and also of the one touched by the section; for if it is thicker and comprises two transverse striæ, it will be looked for in vain in this image, because the interference at the margin then becomes so strong that we can give to the line any interpretation we please. The central nodules and their expansion are not met with with certainty in either series; unfortunately they seem to have broken off at the touch of the knife.

The girdle-band in old valves has always a distinct row of coarse striæ; in the surface-section, fig. 40, this is magnificently brought out. These striæ are about half as fine as the transverse striæ of the ventral valve. In the younger part of an old valve, or in a young valve, the striæ on the girdle-band are very indistinct. In the transverse sections, inasmuch as the sections are in the direction of these striæ, nothing can be seen; one observes no differentiation whatever in this membrane except that sometimes irregularly a dot appears on the inner side, which may indicate the delicate lines running parallel to the marginal lines. The whole matter is to me doubtful. I cannot explain the extremely fine structureless section occurring at the margin of the surface section 1. Since the girdle-band has no such non-striated portions in the surface view, it may possibly be an outer substance hardened by the alcohol.

The serial sections which were made in a direction 90° from the preceding (22 in number) cut through the surface from first to last; but shortly after the first and shortly before the last, as a glance at fig. 33 discloses, the transverse lines of the strongly porous valves must, at the point where the two sides run parallel, have been struck exactly vertical to their direction. This, as a matter of course, occurs likewise with several valves situated between the two ends. Further, the girdle-band is seen in several sections, and is cut vertically to its striæ. The most suitable sections through the part of the dorsal valve under examination, as represented in fig. 48, show that the transverse lines, as we learnt from the surface view owe their origin to the delicate but distinctly raised thickening lines on the inner side of the membrane. These fine lines are about $0 \cdot 9\ \mu$ high, the membrane itself is $0 \cdot 5\ \mu$ thick. In examining the sections near to the last one, one detects the fact not quite so distinctly in those which are unquestionably taken through the ventral valve, but I have obtained with a well-regulated position of one section an unequivocal image, fig. 47. Between the transverse striæ lies the chamber, seen only with very fine sections, fig. 50. As a matter of course, the valve-section is in places entirely surrounded by the adjoining girdle-band section. The girdle-band can always be easily distinguished in these sections

by its peculiar regular fine pearl-like sculpture, figs. 45 and 52. Now, what are these pearl rows? I believe they must be interpreted similarly to the sections of the Flensburg *Pleurosigma* described by me (6, pp. 475–8), hence, in this case, probably a long, extended, cylindrical chamber within the membrane. The apparent projection on both sides of the surface must be an optical effect. Clearness in these details with the extreme delicacy of the object is hardly to be expected. The central nodule of the ventral valve is a strong inward-projecting thickening, without any other distinction except that from every side it sends off a thinner line in the transverse direction to the edge of the valve.

§ 2. With this we conclude our examination of sections in general. I believe I have thrown some new light on the complicated structural details of the species *Achnanthes*, although I admit that much remains to be done. With the ample material at hand it became interesting, apart from the above results, to make the attempt to discover the development-processes which take place in the gradual formation of these sculptures during ordinary fission. Now that we know more exactly the connection of the girdle-band with the valves, the former, not being structureless like most of the fresh-water diatoms, will probably furnish data for further elucidation of these hitherto obscure problems. In aid of further research we should also avail ourselves of simple surface-views as well as the examination of numerous freshly imbedded and well-preserved specimens in balsam, because with the help of transverse images the appearances can be correctly explained. I do not hesitate to add here the observations which I have made with a larger number of balsam specimens of *Achnanthes brevipes* even at the risk of engaging in controversy.

Taking a recently divided specimen, such as is shown in fig. 33, and examining it with reference to the formation of the girdle-band, one finds that between the two valves, viz. between the one older and the one younger, there is no space. We observe the marginal line, and close to this extends the young valve. If we keep well in mind the image of the marginal line of another fuller grown specimen, we shall be easily convinced that the younger specimen has only one single line. Fig. 33 shows the frustule at the edge where the young valves have only recently obtained the necessary solidity to enable them to withstand the influence of contracting fluids (I might have started from earlier stages, but my objects not hardened with osmium show all sorts of bendings of the young valves which I attribute to the modus operandi). Adjusting the left cell as the optical middle section one sees the edge-line of the old dorsal valve like projecting nodules: close adjacent is a smaller nodule which can be nothing else than the commencement of formation of the marginal line of the younger ventral valve. On

the surface of the frustule such a second line cannot yet be traced at all; on the contrary the transverse striæ of both valves run to the apparently common marginal line. This companion cell on the right is in this respect slightly more developed, especially at the one end (the lower in the figure). Not only is the small nodule more distinct in the middle section, but it is also more distant from the larger, and on the surface one can clearly see two marginal lines not quite parallel. Fig. 34 gives the line of the optical middle section again, but more highly magnified. Turning now to another still younger specimen, fig. 35, we observe the two marginal lines slightly further apart. The divergence of the lines continues until the cell obtains the requisite breadth to divide anew, fig. 37. The question arises with this divergence, what becomes of the girdle-band and how is a new one formed? With regard to the old, one sees clearly the edges are extending over the other, of course mostly only with an immersion objective, and it would easily be overlooked if we did not know where to search for it from Pfitzer's pioneer work. With regard to the processes accompanying the formation and development of a new girdle-band we find but little information in Pfitzer (19, p. 56). He states that the girdle-band in *Pinnularia* is formed unusually late, only after the new valves are complete, and then where it adheres to the valve; that it is seen almost at first in its definite thickness reaching slowly to its normal breadth. According to Pfitzer (19, p. 9) the girdle-band has an outer edge in organic connection with the valve, and an inner free edge touching the other ring but not grown together.

With *Achnanthes*—and here the non-existing marginal line of *Pinnularia* renders capital service—we can establish with all desirable certainty that the girdle originates in these lines. One has only to go backwards in the various stages of development in order to establish the fact. At the point where the distance between the old and the young line can be well observed, one sees distinctly with an oblique position, fig. 36, that the cell-wall between the two lines is of double thickness, hence at that point there must be already a younger girdle-band. Of course, with the extreme thinness of the two bands the duplicature cannot be observed directly; the line expressing one cleft extends, as far as I see, up to the young marginal line, fig. 36, *r l*. But since this was attached originally to the older line, the girdle-band without doubt is so far a double membrane, as it has already been rendered probable by its thickness. Following up backwards this very thin narrow girdle-band, fig. 33, on the left, we find here its origin in the depression of the marginal line. We further deduce from these *Achnanthes* images that, according to my examination, it is clearly evident the girdle-band from its commencement is attached to the cell, since it fills up entirely the inner space

between the two marginal lines. From this I deduce further: there is no free edge of the girdle-band, such as Pfitzer has described with *Pinnularia*, anyhow not so long as the cell is only of moderate breadth; both edges are grown to it.*

When this connection ceases must be discovered by future researches. But there can be no doubt that at some time or other a process of forcible separation must take place. This separation always occurs in a segment of the old marginal line. We are therefore justified in stating that at that spot the new formation of cellulose takes place, whilst further on towards the new line, the membrane is already solidified and capable of resistance. Some proof of the correctness of this view is found in the development of a strong margin near this spot; the lines become weaker the further one goes from this margin. In the cell, shortly before division, fig. 37, the tearing-off of the young girdle-band has taken place. This looks like the signal for a new division; at the moment of tearing off, the compressed contents in the rigid cell-envelope become suddenly free, at least in one direction, and can hence extend, inasmuch as the girdle-bands are drawn out like telescope-tubes. If these views are correct they lead us to the conviction that the older outer girdle-band is a safety-sheath for the inner younger girdle-band; it prevents injuries to the latter whilst partially in a non-silicified condition; it protects with its older strong portion the younger recently formed annular portion of the inner band. From this may be deduced that *Achnanthes* is in many respects similar to the growth of the cell-envelope of *Œdogonium* (may we say to the large marine *Confervæ?*).†

We must now cast a glance again at the sections. None of the uninjured (fig. 43) confirm these assertions; one observes from marginal line to marginal line a fine simple membrane, consequently without doubt twofold. But only when a section is injured and its substance has been slightly removed by the knife during the operation of cutting is the real state of affairs brought to view. In fig. 44, otherwise very similar to fig. 43, we see a portion of such a section in which the young girdle-band can be traced; a depression being nowhere observable in the space up to the old marginal line, the girdle-band must have grown there. We also find in such slightly injured sections clear proof that it easily tears off at the old marginal line. If I wanted to convince the reader of

* I might mention *en passant* the physiological objection against the non-connection of the two valves, that the water must find access to the inner space, however narrow, and would thus come into direct contact with the protoplasm, through which the latter, according to all established experience, would swell and possibly effect a separation of the halves.

† Whether the enlargement of the cell-envelope of *Rhabdonema adriaticum* (*vide* Nägeli and Schwendener, 17, p. 544) has its cause in a similar law seems to me to require fresh investigation.

the accuracy of these views which I acquired in the examination of the sections, I should have been obliged to photograph an entire series.

The question whether the diatoms become smaller through repeated division can be well elucidated with *Achnanthes*, especially if one is possessed of richer material than I have, and by examining and comparing the measurements. In doing this we should start with the marginal lines of very young specimens. What I have seen in my examination of *Achnanthes* preparations confirms the results obtained by Braun and others, especially Pfitzer (19, pp. 20–3, 100–102) with *Himantidium*. I confess I see several specimens in which the younger valve is shorter than the older; but I have also found some where the length is greater than in the older, which may possibly be caused by the girdle-band having enlarged itself at the edge. The normal condition appears to me to be an exact equality of both valve-lengths. On the one hand this follows from the manner above described in which the first traces of the young marginal line are developed, fig. 34, and where with the best methods of measurement no difference will be found. On the other hand one sees, by careful examination of such young cells, that the older girdle-band is always slightly raised, that is to say, about as much as its thickness $0 \cdot 4$–$0 \cdot 5$ μ; to this extent it grows over the old valve. Next, one can often see with *Achnanthes* longer cell-rows in connection, all of equal size. This has been minutely discussed by Pfitzer. We have lastly in *Achnanthes* in so far a very favourable object, that the valves are not similar as with *Pinnularia* and *Himantidium*, but on the contrary are very different, and no definite judgment can be arrived at with regard to age and number of generation. Now, if I examine a few good rows composed of eight frustules, where for example the lowest and oldest ventral valve is together with the youngest dorsal valve coming out of the third division, then I find no difference in size between the grandfather and the great-granddaughter, although the threefold thickness of the girdle-band, always a good measurable size, would have to be deducted with the latter if Pfitzer's theory were in this instance correct. However, who will guarantee that we have here to do with the grandfather and the great-granddaughter? The hundredth division may already have taken place, since it is known that in time only individuals connected by mucus are thrown off. All considered, I am of opinion that *Achnanthes* contradicts rather than confirms Pfitzer's theory, and that the supposed corrective of the cell diminution, namely, the formation of auxospores, may have other purposes. The decision of this question must be left to future investigators. Whether the corner of the ventral valve developing the longer or shorter spine by which this diatom is fastened on other algæ, is of different

structure from the one at the other corner seems probable at the first glance, but nothing definite on that point could be made out. It seems to me that the spine is the outdrawn end of a general gelatinous cover secreted by the entire valve-surface. The cell-nucleus of *Achnanthes*, fig. 46, is a small spherical vesicle of 4 μ in diameter with nucleolus of 1 μ.

9. *Synedra.*

With *Achnanthes* I have given numerous transverse sections of *Synedra Gallionii* Ehrenb., often and everywhere found in Kiel harbour, fig. 53. Beyond its general form very little can be deduced, especially as we are left in the dark as to how the insignificant transverse striæ are caused on the edges of the square.

III. Results and General Remarks.

The detailed researches given in the preceding chapters shall only be mentioned here in so far as they relate to the sculpture of the cell-envelope, whilst I must refer to the above for the facts in connection with the girdle-bands, fission, &c. These researches comprise in all, seventeen varieties of diatoms (*Pinnularia major, viridis*, and *Crabro; Navicula Lyra; Pleurosigma balticum, angulatum, Scalprum; Surirella biseriata; Triceratium Favus; Coscinodiscus radiatus, oculus iridis, centralis*, and *concinnus; Isthmia enervis; Eupodiscus Argus; Achnanthes brevipes*, and *Synedra Gallionii*), which have all been examined by the section-method, also to some extent by other methods. The result is that the marking of the diatom coatings has its origin in various forms of the wall-thickness and in the cavity formation within the membrane. The results can be grouped as follows:—

The marking is caused:—

(1) by the sharply projecting wall-thicknesses.

a, on the inner surface of the membrane:

Achnanthes = transverse striæ, *Isthmia* = valves, probably also *Grammatophora, Epithemia*, and others.†

b, on the outer surface of the membrane:

Isthmia = girdle-band.

(2) by developed chambers within the membrane, and

a, with distinctly observable openings.

* Which are on the outer surface of the cell, whilst they are closed inwards (in a certain degree transition from type 1 *b*):

Triceratium, Coscinodiscus radiatus, and possibly a few other varieties.

† Weiss, 28, p. 9; Müller, 16.

** Which are situated on the inner surface of the membrane where the chambers at the same time have the enormous extent of almost half the breadth of a valve.
Pinnularia, and probably all single striated forms.

b, without distinct openings, but of considerable size.
* With quite smooth chamber-walls:
Coscinodiscus centralis, and others.
** With nodular thickened chamber-walls:
Eupodiscus.

c, closed on all sides, and extremely small, approaching the limit of discrimination:
Pleurosigma, Navicula Lyra, Surirella, Achnanthes (the finer marked variety), and probably most of the finely dotted striated forms.

Having thus given proof of the existence of various types as the cause of the surface-image, the necessity arises of refuting those investigators who constantly talk of a diatom sculpture in general, of surface-sculptures, of furrows, cup-like depressions, hemispherical-shaped prominences, &c. In so far as this has not already been done in my paper I now undertake the task.

Prof. Weiss propounded in 1871 (28) an entirely new view of the sculpture of diatoms, which is formulated by him (pp. 15–6) as follows: "The markings of the various diatom species, however different they may appear under low magnification, differ only apparently; under high magnification, and with a correct interpretation of the sculpture, all diatoms are constructed on the same principle, namely, they consist of more or less polygonal cellules, the walls of which, with low magnification, produce and condition the configuration of the so-called markings." The inner cavity he compares (p. 9, footnote) with the embryo-sac of the higher plants. The notion that the envelope consists of numerous minute cells is so thoroughly erroneous that we need not quarrel about it. The attributes of a cell do not consist, according to our present knowledge, in the wall alone which surrounds a cavity, and it is impossible to look upon each cavity as a cell-lumen even if it should have regular form. The discovery of nuclei within the so-called cells (p. 30) must be traced back to an error in the examination; they would never have escaped me in my manifold staining processes. Nuclei which take up no colour I may say do not exist. The idea that all diatoms have a common sculpture, I contradict most emphatically. I cannot at all comprehend how Prof. Weiss, with his great knowledge of details, and with the enormous quantity of material at his disposal, can have arrived at such an opinion. We must, however, give Weiss the credit that he was the first to demonstrate that the presence of cavities closed

on all sides was the cause of the marking during the development of the valve. Considering the criticisms Weiss's work has experienced through the erroneous theory of furrows, sculptures, &c., the credit due to him must be kept prominently in view.

Of similar tendency are the works of Count Castracane, for which I refer to Just's Botan. Jahresb., 1873. It will be equally unnecessary to enter upon their contents.

I have at various times in the course of this paper referred to Prof. Pfitzer's epoch-making work (19). I am obliged to speak of it once more, because at the conclusion, speaking generally of the cell-envelope of diatoms (p. 174), he reproaches me with having in my *Pleurosigma* researches insufficiently estimated the possibility that the connections between the two surfaces of the cell-wall are distinguished from the interspaces by the stronger refractive power due to the molecular constitution. Then he refers to the bast-cells which have similar sculpture, and as worthy of notice he mentions that with diatoms differences could not usually be due to water, but to silica-contents. I do not know Pfitzer's reason for this statement; I have fully explained (6, p. 474) that I have examined fresh specimens which had been boiled in nitric acid and in chlorate of potash, and further (p. 485) that through continued boiling the sculpture does not alter. In the latter case, surely nothing else but silicic acid remains; then what does he mean by making a difference by saying silica-contents? The transverse section of a boiled valve shows exactly the same walls as previously. It appears to me that my demonstration of closed cavities came to Pfitzer's notice at an inopportune moment, because in the same journal he brought forward his furrow theory which, as we have seen above, is wrong in every respect. Since *Pinnularia* seems to be the only diatom examined by Pfitzer by the section method, in order to discover its sculpture, he adopted it as the type of diatom sculpture, and when, soon afterwards, Müller proved real outer openings in *Triceratium* and tried to make useless corrections of my work, Pfitzer evidently believed that I had fallen into error, and that his so-called surface-sculpture was a property common to all diatom frustules, *Pleurosigma* included. In proof of this, one need only glance at Pfitzer's subsequent writings. Let me only draw attention to his latest (20), from which we might infer that it expounded to some extent the latest views on the subject. But about the structure of the cell-wall it contains nothing other than Pfitzer's furrow theory, and O. Müller's sculpture of *Triceratium*.

Another paper which we have to discuss is by Prof. Abbe: 'Beiträge zur Theorie des Mikroskops.' In this work (1, p. 450) it is demonstrated "that all the finer sculpture of an object, of which the elements are small and close enough to produce by their

proximity an observable diffraction phenomenon, are not imaged geometrically in the Microscope, that is to say, not as if the homofocal emergent pencils of rays from the object represented it point for point on one image-surface." From this he draws the conclusion (p. 453)—"all attempts to determine the sculpture of the finer diatom-valves by morphological interpretation of their microscopical images seem founded on inadmissible premises. Whether *Pleurosigma angulatum* has two or three systems of striæ or whether real striæ are there at all, or whether the observed markings are caused by isolated elevations or isolated depressions no Microscope can determine however perfect it may be or however strong its magnifying power." Further (p. 454)—"that the same condition of things exists very nearly for a great number of purely organic images in histological work, can be learnt by the example of striped muscular fibre. In good preparations the diffraction phenomena can be easily observed, and their effects in the microscopical image can be studied experimentally in the former-described manner. The manifold differences in the character of the image explain to some extent the disputes which have arisen between different investigators on this point; but at the same time they also establish the impossibility of stating anything definite about their real organic composition in the sense of the attempts made hitherto."

I am not aware whether Professor Abbe still clings to these views expressed in 1873, or whether he has since convinced himself of their error. From his publications which I have since occasionally seen, I believe he still holds to the former opinion. These theses figure as principal results in a journal of eminence, which must be read by everybody who wishes to keep an account of what he sees in his Microscope. Therefore I consider a refutation of these theses in this place a necessity.

Since the structure of muscular fibre and the differences amongst histologists of that date are put forward as examples of the correctness of the assertions, it may be well to bear in mind that the greater number of histologists have not adopted in their researches Prof. Abbe's views; and that now-a-days the complicated structure of the transversely striated muscle-fibre is nearly established. This is not only valid as regards the single layers composing the fibre, but also for the double-refraction of certain parts, of which Abbe also states (p. 453), it was futile to entertain the idea. I will not here enter into the full details how, at the commencement of the last decade, the confusion chiefly brought about by Heppner's wrong views about the muscle structure was dispelled by my work (8), based on the examination of an unusually favourable object, and I likewise demonstrated at the same time that with the application of good hardening methods one can

obtain similar results on other objects, but less distinctly. Shortly afterwards, the classical works of Engelmann, and more recently of Merkel, whilst confirming the complicated muscle structure and further by investigating the relations of the elementary particles before and after the contraction, have closed the question for some time to come.

If after this Prof. Abbe's objection against muscle sculpture in general is tacitly accepted as set aside, then, in view of the fact that among the numerous diatom investigators hardly one has seriously occupied himself with the structure of diatoms, it becomes all the more difficult to controvert Abbe's views since I am the only one to whom falls the task of doing so. I must not forget, however, that Dr. Altmann has every now and then vindicated my views against Abbe.*

It would lead too far away from our subject if I were here to enter on the merits of their differences; he who takes an interest therein should read Archiv für Anat., 1880, pp. 111 *et seq.* In our present discussion it is enough that all my results obtained hitherto are in direct contradiction to Abbe. Any one desirous of arriving at a definite opinion can inform himself by my diagrams and photographs, or by repeating my experiments. Suppose the student in microscopy investigates the sculpture of an object which is unknown to him, limiting himself to the surface-view only, say, for instance, the *Pleurosigma* valve, it is certain that he will be unable to solve various doubts, and in this I quite agree with Prof. Abbe; he will not be able to decide whether certain lines are raised or depressed, whether they are situated inside or outside; on this subject microscopical literature records the most unfruitful squabbles. But if the investigator examines the object by sections and makes casts of the surface, and makes use of the staining processes, &c., and finds, for example, exactly at the place of a previously doubtful line a projection, then it becomes immaterial to him whether the Microscope deceives us in the surface-view and gives images which do not correspond to reality. If the Microscope deceives us in one case, then it also does so in others. The change in the methods of investigation puts us in the position to find out the truth. As soon as the investigator takes the result obtained by all his methods and compares it with the surface-image, he will in most cases have answers to all his questions without being obliged to enter into the depths of the diffraction theory. I observed these maxims in my work on *Pleurosigma* sculpture, and I hold to them at the present day.

To this cannot be opposed the fact that one can obtain by artificial means images like diatom markings, and such diffraction-

* Personally I do not know Dr. Altmann, therefore I take this opportunity to tender him my best thanks.

spectra as diatoms produce, and that therefore the microscopical image is unreliable, and that for this reason no Microscope could clear up the true facts. The first portion of the sentence I admit, but the second I deny. That the half wave-length of light *in praxis* indicates the limit beyond which in 1869 no Microscope showed details, I had clearly demonstrated in my paper on the optical appearances in diatoms (5); the great honour of having proved theoretically the existence of this limit is due to Prof. Abbe. I had surmised conclusions on the results of my diffraction studies on the finer sculpture details, which I considered unreliable after having successfully used the section method. Several other objects furnish diffraction-spectra, although they are of totally different sculpture which we cannot bring into parallel with the diatoms: for instance, butterfly-scales,* and the skin of the Ascarides whose diffraction phenomena have been studied by Leuckart (12, vol. ii. p. 164). From the latter nobody can arrive at definite conclusions on the sculpture; but it would be wrong to assert that no Microscope in the world could elucidate it. Summing up we may say: the diffraction phenomena suggest only the existence of small particles of approximately equal size in layers, but they convey nothing as to their form or arrangement. The diffraction theory does not put a stop to the closer investigation of the sculpture of muscles, diatoms, &c., and Abbe's assertion that we could never arrive at anything reliable about this sculpture is unfounded and was practically refuted at the time he published it. With this I believe to have given sufficient courage to all timid students to continue their researches which otherwise would be without prospect as long as Abbe's opinion predominated.

The latest work by Prof. Strasburger (27, p. 143) treating of the sculpture of the cell-wall of diatoms, mentions me with the very unflattering sentence—"Flögel believed he had found out that the cell-wall contained chambers opening above as well as below." Then comes O. Müller who proves the opening with *Triceratium*. I may expect that Prof. Strasburger after reading my present work will alter his views considerably. Should I be disappointed therein the way would be open to him to investigate the matter himself personally, and I own that among all living botanists, I consider him to be the most able to assist in solving the question. Should he in such case also "believe" he has arrived at results slightly different from mine, I would request him before presenting the world with his results to try again a second and a third time with different weather, with other sections, and with other physical disposition personally, and then he will soon convince himself that his former "belief" was unbelief.

* About their finer sculpture I shall publish my investigations shortly in a zoological journal.

If in the preceding pages one or other essay on this subject, which has appeared during the last decade, has not been mentioned, I would ask indulgence on account of the seclusion of my place of residence; but I believe that no essential questions regarding the subject have been overlooked.

With this I conclude my work, and for the present, on account of other studies, I take leave of a subject to which I owe many pleasant hours of my lifetime. Whether the text-books of botany will take notice of the fruits of my investigation, or whether they will adhere to the old mistakes, may be left to the future. Up to the present I have only seen one work, the excellent synopsis of botany by Leunis, newly edited by Professor Frank, which gives a true account of the newest standpoint in these questions.

Only by constant and persevering work can we expect further progress; it cannot be done by the mere purchase of expensive immersion objectives. He who will only judge from a usurped high position; he who believes he can do something by setting up diffraction theories; he who looks upon diatoms as aggregations of crystals; he who believes he can decide upon all sculpture questions by observation of the surface; he may keep to his own errors, but he must not expect that I should answer his attacks which he has based upon such means in order to find fault with my work, however learned may be his phraseology. Considering my positive results, I must be excused in saying that I will not enter into discussion with such opponents. The literature of the last decade furnishes so many cases where persons who, after their own more or less special occupation with diatoms, look upon themselves as important microscopists, bring to light the greatest imaginable nonsense relating to sculpture questions. If I cannot indulge in the hope of putting a stop to this by my present work, it will no doubt contribute much for the intimate knowledge of these interesting organisms, and when in future the structure of these cell-walls is in question, the works of Pfitzer and Müller will not be exclusively referred to, but precedence will be given to an investigator who ten years ago put the leading facts into clear light.

Lastly, I have to thank those scientists who sent me their papers, also Herr Möller, of Wedel, for sending various material for investigation.

EXPLANATION OF PLATES.

All the figures have been drawn by the excellent 1/18-in. objective of Dr. Hugo Schröder. All are magnified 1550, unless otherwise stated. The variety in the amplification is due to the change of the eye-pieces and the alteration of the correction-adjustment. They are, with the exception of fig. 7, no flighty sketches, drawn after mere eye measurements, but all dimensions are based on micrometrical measurements.

PLATE VIII.

Figs. 1–7.—*Pinnularia major.*

k a, chamber.
m e, median } ends of the same.
l e, lateral }
k ö, entrance to the chamber.
m r, median } edge of the opening.
l r, lateral }
m i, mid-rib.

Fig. 1.—Transverse section through a valve touching the chamber-openings somewhere in the line at 4 in photograph 1 (or perhaps nearer the central nodule).

Fig. 2.—Transverse section about the same place, line 5, in which is contained the vertical partition-wall between two chambers, the openings indistinct.

Fig. 3.—Middle portion of a similar transverse section to illustrate a very common appearance of the sloping away of the middle furrow. *s*, the closing envelope which in many cases is torn during cutting, whereby balsam enters into the cleft and produces the appearance of a continuous cleft through the entire membrane.

Fig. 4.—Transverse section touching the centre of the central nodule (line 3 in photograph 1).

Fig. 5.—Part of a longitudinal section touching the chamber openings, i. e. in the direction of the dotted line 1 in figs. 1 and 2, or photograph 1. *a f* outer surface, and *i f* inner surface of the cell-wall; *k w*, a vertical partition-wall between two chambers.

Fig. 6.—Portion of a longitudinal section along the side of the chamber openings, i. e. in the direction of the dotted line 2 in figs. 1 and 2, or photograph 1. The membrane on the inner surface is much stronger than that on the outer surface.

Fig. 7.—Diagrammatical figure of a collodion cast. *a*, a single T-shaped continuation in side view (as it becomes elucidated by the different focal positions). *b*, a group of the same, in perspective as seen from above. *z*, the smooth collodion surface. *c*, a piece of the serrated stripe which is formed along the chamber openings, and on which the T continuations stand like a row of trees. *x*, the collodion thread which was in the chamber. *y*, the spine of the same, which in consequence of the collodion contained in the opening contracts.

Fig. 8.—*Pinnularia* (*Navicula*) *Crabro.*

Transverse section from the middle of the valve. *k a*, chamber; *k ö*, opening of the same. *g b*, girdle-bands; the outer has in all sections the position figured; the second valve is wanting.

Figs. 9–12.—*Navicula Lyra.*

Three sections out of a series of 27 transverse sections through one valve.

Fig. 9.—Middle section (No. 13) touching the central nodule *m k*, which forms at that point a very flat thickening. *k a*, chambers.

Fig. 10.—Four sections further on (No. 17). *m r*, mid-rib. *l p*, lyra plates. *k a*, chambers.

Fig. 11.—Section near the end of a valve (No. 1).

Fig. 12.—Small portion of the surface-view of a valve of somewhat considerable size, corresponding to fig. 10.

PLATE IX.

Figs. 13–20.—*Surirella biseriata.*

q l, transverse ribs.
m r, mid-rib.
f l, wing.
r r, marginal tube in the wing.

Figs. 13–19 × 830.

Fig. 13.—Transverse section No. 2
„ 14. „ „ „ 9
„ 15. „ „ „ 39
„ 16. „ „ „ 40
„ 17. „ „ „ 66
} through one and the same valve.

„ 18.—Portion of the longitudinal section No. 1
„ 19.—Longitudinal section „ 8
} through one and the same valve.

„ 20.—Portion of the section No. 8.

The longitudinal section, fig. 19, corresponds to the dotted line in the transverse sections figs. 15 and 16. In figs. 13, 15, and 16 the more faint contours indicate the outlines of the membrane with slight change of focus, corresponding to the undulations in fig. 19. The small continuation *f* at the edge of several transverse sections is probably due to the adhesion of the girdle-band.

The thick longitudinal section fig. 18 comprises nearly the entire wing; the fig. in consequence shows a portion of the wing in surface view. *a*, the places where both membranes of the fold cling together, corresponding to fig. 14 in transverse section. *b*, the folds, but not clinging together, i. e. the tubes which connect the cell-lumen with the continuous marginal tube, corresponding to fig. 15 transverse section.

Figs. 21–22.—*Triceratium Favus.*

Fig. 21.—One end of a section going nearly through the middle of a valve. *a f*, outer surface. *i f*, inner surface. *r l*, marginal ridge. *n*, portion where the section goes through the hexagonal prismatic chambers, consequently touching the chamber-openings *k ō*. *w*, portion of a section near the edge of a chamber, consequently the vertex shows a connection of the heads of the net-lines. *d*, spines in the angles between the hexagons. *g r*, basal membrane.

Fig. 22.—Similar section, touching the middle of one of the three protuberances.

Figs. 23–8.—*Coscinodiscus radiatus.*

Fig. 23.—Marginal portion of the middle section of a specimen at the moment of division (from the Norwegian coast). *g r'*, basal membrane of the original cell. *g r''*, basal membrane of the valve in process of formation. *g b*, the girdle-bands. *a b s*, the nodule of which mention is made in the text. *p r*, protoplasm.

Fig. 24.—Marginal portion of a middle section through an undivided specimen. The letters have the same signification as in fig. 23.

Fig. 25.—The first section from the series from which the preceding was taken; the girdle-band *g b* in surface view with the very small chambers of the margin *r k*.

Fig. 26.—Small portion of the surface view of a specimen (from the marl slate of Oran) focused to the plane indicated by line 1, fig. 23. *k ō*, chamber openings.

Fig. 27.—Similar portion with slightly lower focal adjustment, line 2, fig. 23.

Fig. 28.—Portion of a specimen from the edge with abnormally thick chamber-walls.

Fig. 29.—*Coscinodiscus oculus iridis.*

Small portion of a vertical section. *a f*, outer surface, *i f*, inner surface of the membrane.

Fig. 30.—*Coscinodiscus centralis.*

Portion of a section through a valve with unusually coarse marking. *a f*, outer surface; *i f*, inner surface.

Fig. 31.—*Coscinodiscus concinnus.*

Portion of a thin section; outer as well as inner surface can only be distinguished at the common curve (not figured).

Fig. 32.—*Eupodiscus argus.* (Omitted.)

PLATES X. AND XI.

Figs. 33–52.—*Achnanthes brevipes.*

m k, central node.
d s, dorsal valve.
v s, ventral valve.
r l, marginal ridge (*r l'* old, *r l''* young).
g b, girdle-band.
s z, marginal view of the same.

Fig. 33 × 670.—A chain consisting of two young frustules. The cell on the left is figured in full detail in the manner usually adopted in representing diatoms; i. e. by focusing as a whole. The cell on the right is naturally similarly conditioned. The transverse lines are only indicated, but for the central part the highest focus has been chosen for the representation; it brings to view the marginal striæ *s z'* of the old girdle-band. Further on towards the edge it is focused a little lower; then only are seen the very short dotted striæ *s z''* of the young girdle-band between the two marginal ridges. In the cell on the right, near one end, the young ridge has separated considerably more from the old one than at the other end. The numbers refer to the direction of the sections, figs. 40–2.

Fig. 34.—The upper edge of the preceding fig. under exact medium focus. The marginal ridge shows a saddle-shaped depression, the small elevation is the young ridge in process of splitting away from the old one. The depression between the two must be looked upon as the first visible indication of the young girdle-band. The old girdle-bands extend one over the other only in the direction *s*. The cells are without doubt completely closed. The girdle-band is raised at the marginal ridge slightly. Marking of the surface view given with the valves below.

Fig. 35 × 670.—A chain similar to the preceding, but a little older; the young marginal ridges *r l''* are further apart from the older *r l'*. Only the striæ of the young girdle-band *s z''* are represented.

Fig. 36.—The upper edge of the left cell in fig. 35, in order to bring to view the relation between the two marginal ridges and the doubly thick membrane between them.

Fig. 37 × 670.—An older cell, probably shortly before division. The peculiarly interrupted striated marking of the girdle bands is given. This is about the most complicated striation of all; between this and fig. 35 one finds all transitions. It seems as though the boxed-up girdle-band had already separated from its marginal ridge.

Fig. 38 × 670.—A dorsal valve and

Fig. 39 × 670.—A ventral valve viewed from the surface with full marking.

Fig. 40 × 660.—Transverse section No. 1,
„ 41 „ „ 5, and
„ 42 „ „ 15
out of a series of 23. They correspond to the dotted lines 1, 2, 3 in fig. 33 (naturally with the modification that we have here to do with a chain of three frustules). Fig. 40, extreme marginal section which has touched only one portion of the lowest cell. Fig. 41, the middle cell partially injured in cutting. Fig. 42, the uppermost cell crumbled out.

Fig. 43.—Transverse section No. 12 of the same series. The uppermost cell quite uninjured. Quite distinctly is here observable the difference in size between the old (*r l'*) and the young (*r l''*) marginal ridge; the hook shape of the former also visible. The valve membrane is distinctly dotted (as expression of the dots between the transverse lines in the surface image). *m r*, mid-ribs.

Fig. 44.—Portion of the same uppermost cell from the transverse section No. 9 of this series. The adjoining cell is split off whereby the duplex of the girdle-band becomes distinct, because in consequence of the fracture both membranes have separated; *g b'* the old, *g b''* the younger girdle-band.

Fig. 45.—Portion of the ventral valve of this uppermost cell to show the mid-rib *m r* and the surrounding fine spaces as in the sections Nos. 8 and 16 of the above series. The fine line *q* is the inner limit of one of the transverse striæ.

Fig. 46.—The dorsal valve of a cell with the cell-nucleus from the second transverse section series.

Fig. 47 × 660.—Longitudinal section through a ventral valve in the direction of line 4, fig. 33.

Fig. 48 × 660.—Longitudinal section through a dorsal valve in the direction of line 5, fig. 33.

Fig. 49 × 660.—Section quite through the girdle-band in the direction of line 6, fig. 33.

Fig. 50.—A portion of fig. 47,
„ 51.— „ „ 48,
„ 52.— „ „ 49,
highly magnified. *q*, the ridge-shaped transverse lines projecting inwards. *p*, the fine dots between them (? chambers).

Fig. 53.—*Synedra Gallionii.*

Any middle transverse section through a frustule.

EXPLANATION OF THE PHOTOGRAPHS DEPOSITED IN THE LIBRARY.

All photographs except No. 12 have been made by me personally without eye-piece according to the old method with wet plates. No touching up has been done to any of them. No faults in the negatives are specially mentioned, but they can easily be distinguished from the objects used in demonstration.

1. *Pinnularia major;* large specimen in balsam; a little more than half a valve. Produced by Schröder's immersion 1/18 in.; × 631.

The lines on the tracing paper covering the photographs which can be connected by a ruler, indicate the direction of the sections in the space between *a* and *b*:—

1	is the direction of the	longitudinal section	fig 5, photograph 3.
2	„	„	6, and portion of photograph 2.
3	„	transverse section	4.
4	„	„	1.
5	„	„	2.
6	„	oblique section, photograph 7.	
7	„	transverse section of the valve *m* in photograph 6.	

On the right-hand side the chamber openings are distinctly seen; in making line *m r* the median edges of these edges are touched; in the same manner *l r* will touch the lateral edges. On the left and in other places on the valve the focus is not so good, although both edges glimmer everywhere.

From *c* to *d* is the region where presumably the mid-rib shows the depression almost at right angles on the transverse section (fig. 3). From *c* to the end-nodule *e*, and from *d* to the line 7, the mid-rib is simply a vertical incision (fig. 1). *f*, irregularly formed chambers on the right; the walls are here black and vanish at the lateral end.

2. *Pinnularia major.* A coarser longitudinal section through two valves lying one in the other. Like all other following sections, so here the section is imbedded in gum, the entire gum-chip surrounded by balsam. Position and magnification as in 1. The focus from *a* to *b* is the best; one sees in the valve on the right the transverse sections of the chambers with the inner membrane which closes the chambers; the section direction is approximately the same as with line 2, photograph 1. In the valve on the left the openings are seen, but in consequence of the great thickness of the section the oblique ridge-shaped vertical chamber-walls glimmer and disturb the image, and which only becomes quite intelligible by photographs 3 and 7. In the lower part is a zigzag-shaped cleft *r* through the gum-chip; there the section is very thick and the focus unsuitable. This will convince us what errors can arise with a coarse object through mistakes in focus and cutting, and which in a less degree occur with finer objects like *Pleurosigma.* The valve on the right has lost the outer membrane, which has apparently stuck on the gum on the right; the vertical chamber-walls are therefore torn off at the point of connection with this outer wall, and the

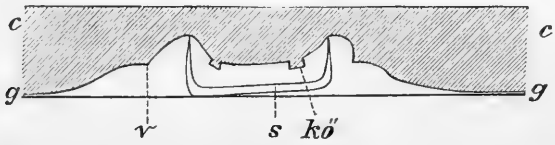
chambers erroneously suggest an outer opening. In the left valve these vertical chamber-walls appear on the inner side serrated (naturally, with both, the inner surface is on the left); this also is an optical delusion. In both valves the very dark walls are much thicker and more clearly expressed than in a reliable image; but the lumen of the chambers is reduced and strongly rounded off (also wrong!). The connection between the vertical walls with outer and inner membrane appears therefore like a thick nodule; whilst with good sections little can be traced of such end thickenings.

3. *Pinnularia major.* Extremely thin longitudinal section exactly through the chamber-openings, focus and magnification as in 1. This is probably the best section in my collection, and can be recommended for all finer measurements. The best focus is from *a* to *b*; less good from *b* to *c*. The section direction runs in the line 1, photograph 1. One sees (best with the help of a lens) the club-like thickening of the chamber-walls; one can measure the thickness of the outer membrane, &c. The inner surface is on the right, proved by the bend in the section. On the left is a surface section of another valve.

4. *Pinnularia major.* Collodion impression of the outer surface of a valve, in air. Produced by Schröder's dry 1/6, × 298. The strongly black marginal line is the expression of an elevation in the collodion originating in the same manner as we shall see when we come to photograph 5. The mid-rib is distinctly seen; it is a delicate ridge, corresponding to the cleft in the valve, and ends at the central nodule with a stronger point. The smooth space on both sides of the mid-rib slopes, beginning at that portion of the surface where the chambers are situated in the valve, and is there slightly different; this difference probably originates by a change in the evaporation processes. Starting from the upper corner on the right we observe on the cast a chain of numerous small crystals of unknown origin (on the preparation itself). The lines on the left are Newton's rings in the thin collodion film. All other dotting is the granulation of the collodion surface.

5. *Pinnularia major.* Collodion impression of the inner surface of a valve. Produced as No. 4, same magnification. With regard to the general sketch of the valve the following is to be observed:—If in making a collodion cast of a valve (shown in fig. 119 as *s*) lying with its surface towards the slide (*g*), the fluid

Fig. 119.



naturally fills up at first all the inner spaces. In hardening the mass contracts, and occupies afterwards as a solid film the shaded space *c* in the image. The quantity that originally entered into the angle between valve and glass thins away and appears as projection *v*; this accounts for the remarkable enlargement of the outline in the cast in comparison with that of the valve. Next to the so-formed dark surrounding edge follows an inner portion partly lighter, partly darker, and often interrupted. This is the depressed furrow in which lay the extreme edge of the valve (*vide* photograph 6), and had been so squeezed into the collodion that during the separation from the valve many small fragments of this sculptureless edge remained behind in the furrow. On the surface one observes the impression of the central nodule, and further two longitudinal lines. These represent the collodion which ran into the chambers (*vide* text), and are raised ribs (*k ö* in the fig.). In several places are seen the threads described in the text. A part of this longitudinal line is drawn in fig. 7; *conf.* their description. (These raised ribs I have sometimes seen on casts of extremely small undefined *Pinnularia*; one would otherwise only look for them in *Navicula*. The real details can only be learnt from large varieties.) On the left of the cast a large air-bubble had been enclosed in the collodion; near its centre we observe the granulation, elsewhere so distinct, decrease, which circumstance I have made use of for the explanation of the faint granulation

above the chambers on photograph 4. In the centre of the bubble Newton's rings. The *Stauroneis* valve lying at the side is not free from the collodion.

6. *Pinnularia major*. A number of exact transverse sections. Produced like No. 1, × 647. The section made after method I. is of exquisite thinness and flatness. It was photographed a few days after being made, therefore the little air-bubbles which ought to be formed in the chambers during the hardening of the gum are visible, whilst with other sections kept for some time they have been mostly absorbed by the balsam. Altogether transverse sections of twenty valves can be seen, and they are lettered A to U. Of A and B only portions are seen, but the others are entire.

The focus on the left not very good; on the right chamber opening very fine; at the lateral edge of the same an oval air-bubble in the chamber.

D, focus in the left not suitable; on the right median end of the chamber, and median edge of its opening fairly good; in the extreme lateral end of the chamber an air-bubble.

E, similar section to M, but broken in the middle line; on the left median end of the chamber pretty good.

F, broken up and useless.

G, a tolerably good transverse section, a little broken up; chambers indistinct; mid-rib good; has the angle-depression of fig. 3.

H, only good above; shows the fine pointing of the valve margin very sharp; in it several air-bubbles; lower down, broken up.

I, quite similar.

K, very beautiful section; chamber opening on the left is good, but not so distinct on the right; mid-rib is observable as a delicate cleft not quite through.

L, similar section, mid-rib burst; on the left, chamber and its opening very fine; a few air-bubbles in the lateral end do not interfere much.

M, one of the most magnificent sections, quite close to the central nodule (corresponding to the line 7 in photograph 1). The mid-rib is here an unusually deep vertical narrow cleft; one sees the closing envelope very distinctly (with a lens); chamber of the upper half good, that of the lower indistinct, because only the partition-walls remain (like fig. 2).

N, only the lower good, crushed at the top.

O, central nodule section, hardly of use.

P, useless.

Q, apparently central nodule section, but injured; focus unsuitable.

R, focus unsuitable; the chambers can be recognized in outline.

S, particularly beautiful, showing the mid-rib as a right-angled bent cleft, like fig. 2; the chambers are tolerably good in the upper half.

T, chamber of the upper half very good, also its narrowed lateral end; the mid-rib is broken, and the lower half useless.

U, good section, but the focus not sharp; both chambers visible.

The section encloses a girdle-band section.

7. *Pinnularia major*. Slightly oblique longitudinal section, produced like No. 1, × 650. This is another most elegant section in the direction of line 6 in photograph 1, and represents the end portion from line 4 to *f*. This, like photograph 3, is very suitable for all finer measurements under the lens. The following are chiefly remarkable:—In the region *a* the vertical division-walls thickened below between the chambers; the openings of the chambers; the very thin outer membrane. At the point *b* the lateral edge of a chamber opening is touched, and there appears in great strength the inner membrane (closing the chamber below). At *c*, is a favourable image of a chamber lumen: the thin outer membrane, the more than twice as thick inner membrane, rounding off of the square transverse section of the lumen at the inner membrane.

8. *Eupodiscus argus*. Middle section through a valve. Produced with Schröder's 1/6 dry objective, × 298. On the left is observed the inner cavity in which is an air-bubble at the end. In the middle region is a faint indication of vertical chamber-walls. Spine-like points are observable on the lower outer surface of the valve, similar to *Triceratium* spines.

9 and 10. *Pleurosigma balticum*. Transverse sections, produced like 1, × 669. The section is made after method I. (in pure gum in collodion), and was photo-

graphed a few weeks after. It is No. 76 out of 150 transverse sections. Through a number of 14–16 frustules, partly parallel, partly one on the other. Image 9 was taken with somewhat higher focus, and image 10 with lower focus; the difference is naturally very insignificant. For the examination of these two images and of photograph 11 a lens should be used. For the representation of the sculpture my former description of the transverse sections of *P. balticum* should be referred to (6, pp. 481–5, figs. 13, 14 and 15). The separate frustules are marked A–L. For the comprehension of the arrangement of the frustules in comparison with photograph 11, we must observe that only the *Pleurosigma* A to D are in the original position, that the gum section on the right of D on account of extreme thinness is broken off, and that this broken-off and still further broken-up portion has fallen obliquely across the other portion which remained intact. The thinness of the gum-chip in this instance can be best estimated by noting that hardly any trace of the collodion limit lines can be seen (*vide* photograph 11), which must have existed below B and D. About the separate sections the following is to be observed:—

A, very thick section, kidney-shaped within. The left valve is broken in the middle, only the one half is seen. The right valve is broken up, but both the chief and secondary ribs, with a portion of thin membrane attached to the former distinctly visible; the chambers slightly indicated.

B, a slightly thinner section, strongly notched within. The left valve twice fractured; the right valve quite uninjured; only well focused in image 10; the thin membrane-stria next to the mid-rib very beautiful; slight indication of chambers; the girdle-band at the top is in normal position, below out of place, in photograph 10 clearly duplex.

C, section thinner than B. Content wanting. The upper valve uninjured. Best focus in photograph 9; indication of chambers very good, particularly in the left half; a depressed furrow beside the mid-rib good, also the secondary rib. The lower valve is broken in the thin portion, although both halves are not much displaced. Focus in both images not exact. The left girdle-band is injured; on the right clearly duplex; both still adhere to their original valve, although slightly displaced one towards the other.

D, this magnificent central nodule section, which forms the chief object of representation, and is rendered on a larger scale in photograph 12, I shall describe further on.

E, injured section, only the lower valve good. The content adheres to the girdle-band. On the left a few fragments of valve transverse sections.

F, a much injured section. The upper valve broken in two pieces, but the fracture is not in the thin membrane stria; the half lying a little higher shows in photograph 10 very good indications of chambers; the lower half to which is attached the content is not so good; tolerable in photograph 9. The lower valve broken up; the girdle-band has got out of place.

G, imperfect section, which very clearly proves what kinds of deception can take place in researches not conducted critically. In the half-valve on the right at the top one sees in photograph 9, without much trouble, the outlines of a base membrane, with ridge elevations noded at the ends. A little more imagination will add outer openings of the chambers. Photograph 10 destroys all these illusions, and proves at the same time that this section is much too thick for such studies; it is almost exactly the reduced copy of *Pinnularia*, photograph 2 at *r* (*vide supra*).

11. *Pleurosigma balticum.* Everything like 9 and 10, except the transverse section No. 80 out of the same series (Nos. 77–8–9 were useless fragments cut through totally different portions of the bundle). This image chiefly serves to show that by using my section method the separate frustules can be identified from section to section, whereby real series of sections can be obtained. A to D can be easily recognized by comparing with images 9 and 10. Below B D E run two slightly bent parallel lines through the field of view; these form the limit of the transversely cut delicate collodion film on which the arrangement of the *Pleurosigma* took place. On the right of E the section is broken off and another gum-chip has fallen obliquely on it; the frustule sections H and I therefore lie one upon the other. For the separate sections the following remarks may be serviceable:—

A, very thick and useless, in some places indications of chambers.

B, scarcely better; the right valve has possibly a useful thinness, but is not distinct.

C, has in the upper valve the deceptive image described above with G.

D, the focus is tolerably good only for the lower valve, where at the same time is visible how the image of the central nodule transverse section passes over into the ordinary transverse section image.

E, F, G, focus entirely wrong.

H, shows specially the asymmetry of the secondary rib, exactly as I have described above (fig. 13). Indication of chambers in some places good.

I, indistinct.

K and L, two fragments of valve sections, the former showing the chambers very well.

12. *Pleurosigma balticum.* The frustule D from the photograph 10. Enlarged from the negative by means of the ordinary portrait objective. Total magnification, 2340. The image has been made, fearing that the delicacies of the negative during the printing would suffer considerably, and further to facilitate measurements. The valve *a'* is uninjured throughout, and gives an unblemished picture of the central nodule. The chambers disappear to the eye at some distance from the centre. Instead of the usual membrane-thinning commencing with mid-rib and secondary rib, the wall remains solid throughout (*b'*), but has two very small projections inwards (*c'*), between which is a slight depression. The chamber-walls are here distinct, the cavities dark; the focus of photograph 9 is for this valve more advantageous. The valve *a''* is uninjured in the lower half, but the two projections *c''* of the central nodule are still visible; evidently here has been the extreme fine edge of the section. By comparing photograph 9 with it one detects faint traces of this lower half-valve, which we find again indicated in photograph 12. From the preceding we deduce that this section of the upper half-valve is sufficiently thin for the minutest investigations. The chambers are seen in full clearness and in such accordance with my former diagrams as if this preparation had served for them as model. The girdle-band *g b'* is not quite distinct, in consequence of being crumbled; the other *g b''* partly covered by the section of the frustule E.

I have formerly given the greatest thickness of the cell-wall as $1{\cdot}8\ \mu$. Considering what is clear in the valve *a'* and what is dark in *a''*, and that one must not reckon in *a'* the dark seam beyond the clear space, we get in this photograph the greatest thickness of the wall near the central nodule as 4·2 mm., consequently the true thickness is $\frac{4{\cdot}2}{2340} = 1{\cdot}8\ \mu$. The height of a chamber lumen may be estimated at 1/3 of this size; therefore these are all valves not beyond the power of microscopical observation.

Valve E *a* belongs to frustule E, also the girdle-band E *g b* and the contained portion E *i*. In the former is seen the indication of chambers tolerably well; the same may be seen in the valve fragment lying on the left.

13 and 14. *Triceratium Favus.* Section No. 11 from a series of 19 vertical sections through a valve. Fig. 13 with high focusing; fig. 14 with low focusing. Produced with Seibert and Krafft's immersion VII. *b*; × 652. The inner surface of the valve is turned downwards.

15 and 16. *Coscinodiscus radiatus.* Middle section from a series of 31 vertical sections through a specimen in process of division. Produced like No. 1; × 660. Fig. 15, for the greater part of the section correct focus, especially reliable in the centre and a little lower. Here are the T-figures of the chamber-walls distinct, also the four base-membranes. Of less use is the lower end, although pretty distinct. For the upper end the focus is unsuitable. Image 16, gives the correct focus for the upper end, but not so well for the lower end; the middle is quite unreliable. At both ends is seen the overlapping of the thick girdle-bands.

17. *Triceratium Favus.* Thin but not quite plane section. Produced like 1; × 680. The section direction is not exactly through the middle of the hexagons, therefore every pair of chamber-walls are brought closer and connected on the outer surface (on the left), and thus between each pair there is a slightly larger

space (*a*); here the outer entrance-opening is touched (*b*). The section is only thin enough and focused correctly at *a*. Below, near the marginal portion, another piece of diatom lying by accident on the valve has been touched.

18. *Surirella biseriata.* Collodion cast in air. Production and magnification like photograph 4; it is the cast of the inner surface of a valve. The deep black edge is a raised collodion ridge, which is formed on the outer side of the wing as described above with *Pinnularia*. The distinct border next to it is a deep brown of the collodion; in it must have been the valve edge (figs. 13–17). The dark ribs on the surface are raised places, i. e. wave-elevations, the clearer inner spaces are depressions. At the lateral end of each wave-elevation, not far from the distinct marginal line, is a dark dot. In the cast is a vertical projection; these thorn-like spines naturally are the contracted outlets of the channels. In the mid-rib a stria of the valve has remained behind. Collodion surface remarkably smooth.

19 and 20. *Isthmia enervis.* Two successive sections. Production as in 1; × 633. The one section must be adjusted to the other like a mirror image. The separate sections are A, B, C. The situation of the cells in the gum has unfortunately not been figured before cutting, and it is now almost impossible to define them; but so much is certain, a few sections further on A and B coalesce, consequently both belong to one cell, whilst C is a second cell, apparently touched nearly transversely. B is therefore, as its small extent teaches, doubtless a section through the extended end of the rhomboidal cell, either through a free corner or more probably through the isthmus proper. This is here important. 19 is a very thick, 20 is a very thin, section in which the isthmus section is a little injured; the section of the cell C is flapped over at the top or pushed together. In both sections one sees in the ring B on the inner side ridge-projections, which are the cause of the well-defined cell-marking. Had I given this with only one section, some severe critic might have retorted that the ridges might be on the outer side, and that the apparent inner projections were obliquely struck in projecting marginal portions. Such like opposition is refuted by the image of the second section. Designating here the projections, for example, 1, 2, 3, &c., one will find that all fit exactly one to another except that, instead of No. 3, photograph 20, we see two projections standing close together in photograph 19, evidently because here in the first instance an areola corner was touched. This comparison proves further, that the membrane was touched exactly vertically by the section on the right side in photograph 19 (or on the left in photograph 20), but on the opposite side obliquely. The more reliable thinner section 20 proves undoubtedly the turning-in of the ridges and the outer smoothness of the membrane.

The section through the cell C is by far too thick for the study of the sculpture. In section A are found a few places in photograph 19 (just below the middle), where it has the required thinness for the observation of the very thin ridges on the outer side of the membrane. Judging from the numerous examples of these images in other sections I can only declare it to be the girdle-band.

BIBLIOGRAPHY.

1. Abbe, Prof. E.—Beiträge zur Theorie des Mikroskops und der mikroskopischen Wahrnehmung. Arch. f. Mikr. Anatomie, ix. pp. 413–68.
2. Deby, F.—Note sur l'argile des Polders suivie d'une liste de fossiles qui y ont été observés dans la Flandre occidentale. Annales de la Société Malacologique de Belgique, xi. 1876.
3. Dippel, Prof. L.—Beiträge zur Kenntniss der in den Soolwässern von Kreuznach lebenden Diatomeen, sowie über Structur, Theilung, Wachsthum und Bewegung der Diatomeen überhaupt. Kreuznach, 1870.
4. Engelmann, Prof. Th. W.—Neue Methode zur Untersuchung der Sauerstoffausscheidung pflanzlicher und thierischer Organismen. Botanische Zeitung, 1881, pp. 441 *et seq.*
5. Flögel.—Ueber optische Erscheinungen an Diatomeen. Bot. Zeitung, 1869, pp. 713, 729, 753.

6. Flögel.—Untersuchungen über die Structur der Zellwand in der Gattung Pleurosigma. Arch. f. Mikr. Anatomie, vi. pp. 472–514.
7. —— Ueber die Structur der Diatomeenschale. Tageblatt der Versammlung deutscher Naturforscher und Aerzte zu Leipzig, 1872, p. 141.
8. —— Ueber die quergestreiften Muskeln der Milben. Arch. f. Mikr. Anatomie, viii. pp. 69–80.
9. —— Die Diatomaceen in den Grundproben der Expedition zur Untersuchung der Ostsee. Bericht der Pommerania-Expedition, pp. 85–95, 1883.
10. Hallier.—Die Auxosporenbildung bei Cymbella gastroides Kütz. Zeitschrift, Humboldt, April, 1882.
11. Just, Prof.—Botanischer Jahresbericht 1873, &c.
12. Leuckart, Prof.—Die menschlichen Parasiten und die von ihnen herrührenden Krankheiten. 1te Aufl. 1863.
13. Morehouse, G. W.—Silica Films and the Structure of Diatoms. Monthly Microsc. Journal, xv. p. 39.
14. Müller, Otto.—Untersuchungen über den Bau der Zellwand von Triceratium Favus Ehr. SB. der Gesellschaft naturforsch. Freunde zu Berlin vom 17 October 1871, pp. 74–81.
15. —— Ueber den feineren Bau der Zellwand der Bacillariaceen, insbesondere des Triceratium Favus Ehr., und der Pleurosigmen. Reichert's und Du Bois-Reymond's Archiv, 1871, pp. 619–43.
16. —— Ueber den Bau der Zellwand der Bacillarien-Gattung Epithemia Kütz. SB. der Gesellschaft naturforsch. Freunde zu Berlin vom 15 October 1872, pp. 69–71.
17. Nägeli und Schwendener, Profs.—Das Mikroskop. Theorie und Anwendung desselben. 2nd ed. 1877.
18. Pfitzer.—Ueber den Bau und die Zelltheilung der Diatomeen. Bot. Zeitung, 1869, p. 774.
19. —— Untersuchungen über Bau und Entwicklung der Bacillariaceen (Diatomaceen). Botanische Abhandlungen von J. Hanstein, i., 2, pp. 1–189. 1871.
20. —— Die Bacillariaceen (Diatomaceen). In Encyclopädie der Naturwissenschaften, Handbuch der Botanik von Prof. Schenk, 1882, ii. pp. 403–45.
21. Prinz, W.—Etudes sur des coupes de Diatomées observées dans les lames minces de la roche de Nykjöbing (Jutland). Ann. de la Société Belge de Microscopie, vii. 18 0.
22. Rabenhorst, Dr.—Flora europæa Algarum aquæ dulcis et submarinæ. Sectio I. 1864.
23. Schumann, J.—Die Diatomeen der hohen Tatra. 1867.
24. Schultze, Prof. M.—Die Bewegung der Diatomeen. Arch. f. Mikr. Anatomie, i. pp. 376 *et seq.* 1865.
25. Slack, H. J.—On the structure of the valves of *Eupodiscus Argus* and *Isthmia enervis*, showing that their siliceous deposit conforms to the general plan of deposition in simpler form. Monthly Microsc. Journal, viii. (1872) p. 256; i. pp. 123, 186.
26. Stephenson, J. W.—Observations on the optical appearances presented by the inner and outer layer of *Coscinodiscus*, when examined in bisulphide of carbon and in air. With 1 plate. Monthly Microsc. Journal, x. p. 1.
27. Strasburger, Prof. E.—Ueber den Bau und das Wachsthum der Zellhäute. Jena, 1882.
28. Weiss, Prof.—Zum Baue und der Natur der Diatomaceen. SB. der k. Acad. der Wissenschaft, I. Abth. 1871, Feb., pp. 1–37.
29. Wells, S.—The structure of *Eupodiscus Argus*. With 1 plate. Monthly Microsc. Journal, ix. p. 110.

XVII.—*On Drawing Prisms.*

By J. Anthony, M.D. Cantab., F.R.C.P., F.R.M.S.

(*Read* 11*th June*, 1884.)

When the scientist is investigating matters of special interest by means of the Microscope, he naturally wishes to record pictorially what he sees, and particularly if the objects under examination should chance to be of a perishable nature. If he has not undergone some sort of artistic training, his efforts with the pencil will generally fail lamentably to convey an idea of what he sees in the Microscope; his drawing will probably be utterly wanting in "character," and his outlines poor and uncertain—shortcomings which he will probably try to make up for by a painful elaboration of detail. This is not altogether a fancy picture. A man may have a most intense and learned appreciation of what the Microscope reveals to him, and yet be utterly unable to make a reliable sketch, much less a picture. It is under such circumstances that inventive brains have been stimulated to devise appliances which, placed upon the eye-piece of a Microscope, should, by well-known laws, project the Microscopic image on to a blank sheet of paper in front of the observer, who would be enabled to trace with the point of a pencil the outlines and salient points of the shadowy microscopic image.

This is, of course, a very rude description of the general action of all the mechanical aids to drawing from the Microscope, but further on we shall see that special means have been devised to attain special ends.

Three questions have repeatedly been put to me.

1. What is the special advantage of using a drawing prism?
2. Does it require a knowledge of drawing to use it?
3. What form of prism will be the best to employ?

The answer to the first question is easy. The employment of a prism means an enormous saving of time, and not only that, but used with simple precautions, it means the power of delineating with almost rigid accuracy the outline of all objects seen in the Microscope. And this is not all the advantage, for an absolutely identical magnification can be insured in every successive drawing by simply marking on the Microscope a fixed observing or sketching angle, and by using for successive sketches the same objective and same ocular duly armed with the prism. As each drawing is completed, a simple substitution of a micrometer on the stage of the Microscope allows a "scale" to be projected on to the drawing, or on the side of it, which may be thus said to have received its official stamp.

To reply to the second question:—Most assuredly no special knowledge of drawing is needed for making accurate outlines with the aid of a prism; little more than the first lesson in free-hand drawing is required, viz. the power of tracing lines with firmness and certainty of touch.

The third question, as to the best form of prism, will be met by a short review of the various forms of drawing appliances from the days of Wollaston, who devised a prism which in many of its qualities has never been surpassed. In making such a review this evening, as I shall have to "name names," it need hardly be said I shall strive to keep within the bounds of fair criticism, and especially to eschew invidious comparisons. Time would not allow me to go into the optical construction of the various appliances which I shall have to bring before your notice; all these particulars can be learned from the back numbers of our Journal. I prefer to take these little adjuncts to the Microscope just as they were supplied to me by their more or less sanguine inventors, and to narrate what they have respectively done in my hands, premising a hope that as I have had one or the other in pretty constant use for some forty years, a description of their performances will neither be unwelcome nor unprofitable to the practical microscopist.

In illustration of the remarks I have to make, and as showing the various applications and "all round" character of the drawing prism—and particularly in its more recent forms, I venture to exhibit selections from among the thousands of drawings I have made, choosing those which may be said to be typical of the uses of the prism.

The subjects are, as you will see, of all sorts, but having this in common, that they were all drawn under the Microscope; all outlined by the prism. When you see copies from photographs, from book-illustrations, magnifications of the exquisite engravings in Yarrell's 'British Birds,' and Bell's 'Reptiles'—such as the venomous and non-venomous snake—and proceed from these low-power magnifications through the whole range up to the delineations of living diatoms as seen with my grand Tolles 1/25 objective, I think you will feel an incipient respect for the use of the little instrument, the use of which I advocate. Just let me call attention to the important fact, that in each rapidly executed copy of an engraving, every mark of the graver's tool has been indicated at one operation by pen and ink while still under the Microscope; and in mere outlines of microscopic objects—whether executed with pen or pencil, all have been purposely left as they were traced under the instrument; or to use other words familiar to drawing academies, they have not been "touched up."

As an example of the satisfactory character of this untouched outline, I hand round copies of the well-known *Pleurosigma*

angulatum, as executed with various prisms, the sketch of each having occupied as nearly as possible half a minute! Those who have sketched *P. angulatum* will be conscious that several minutes are generally needed to get the peculiar curves of this diatom satisfactorily. Here are many outlines made in succession of this same lorica, to show how identical they all are in character. The large drawing or diagram of some well-known forms of diatoms is a *tour de force*, and here the effect would be better, or easier got, by copying some moderate-sized prism outlines, by means of the pantograph; but the drawing as it stands really was executed under the Microscope; the paper was laid on the ground with a bright light thrown upon it, the Microscope was well raised over the edge of the table. The image—enormously amplified—got from a 1/6 objective, was projected by the prism, and was traced upon the paper by the aid of a pencil; which pencil might be said to be some 5 feet long, inasmuch as it was formed by a crayon tied firmly on a joint of a fishing-rod. That the outline so traced was a bit "shaky," and needed "mending" may well be imagined, but the reparation has, I think, not been made at the expense of the characteristic curves of the various diatoms. I am sure the relative size of each may be depended on, though I must own to depicting the largest and boldest specimen of *P. angulatum* I could lay my hands on.

After this much of preamble, permit me to name the various forms of drawing appliances or prisms from which to make a selection; all of them have some merit, and some of them, as I trust I shall be able to show, are pre-eminently useful. First come "steel disk" or "neutral-tint" glass reflectors; then prisms proper, by Wollaston, Gundlach, Beck, Oberhauser, Zeiss, Nobert, Abbe, Nachet, and Schröder. They may be classed thus, Wollaston, steel disk, and glass reflector can only be used when the Microscope is placed horizontally—a position which is always a more or less cramped one for the observer, and which is all but impossible to adopt in connection with dissections, and indeed with most objects mounted in fluid and more or less free to move in the cells. The prisms of Beck, Gundlach, Zeiss, and Schröder are available when the Microscope is set at the usual observing angle. The prisms of Oberhauser, Nobert, Abbe, and Nachet can only be employed when the Microscope is placed in a vertical position; the image is projected a few inches to the right-hand side of the Microscope, and falls on a sheet of paper fixed to a 2 ft. drawing board, so that the point of a pencil, which is held in the right hand, is in a convenient position to trace the outline of the projected image.

I will now proceed to describe the special qualities which some of these prisms have as adapting them for particular purposes.

The "reflectors" and the "Gundlach" will be found in use to "invert the image"; this inversion is very troublesome, and if not well understood, and met with certain devices, is apt to lead the draughtsman into endless confusion. In practice when you use one of these inverters you are compelled to sketch from the one side of a slide of objects, and to fill in detail from the other, and as a clever writer has pointed out with respect to this arrangement, "the back and the front of an object are not always alike."

The image got by a Wollaston prism is so excellent that this instrument would always be used, were it not that the setting of the Microscope in a horizontal position, the re-arrangement of the light, &c., the dependent position of the eye while drawing, the more or less cramped position, and other difficulties with respect to the slipping of fluid preparations oblige one to employ more convenient though perhaps in other respects less satisfactory appliances. Of the prisms used at the ordinary observing angle of the Microscope, Gundlach's, as I said, inverts the image, and I am sorry to say that the Zeiss prism, though it is quite satisfactory in my hands, in most respects, projects the image so far forward as almost to come upon the stand of the Microscope, and so practically cramps the position of the drawing paper or board; I therefore seldom use it. I like the Beck prism, and I make perhaps more use of it than of any other, as the light transmitted, the field, and the sight of the pencil are all satisfactory.

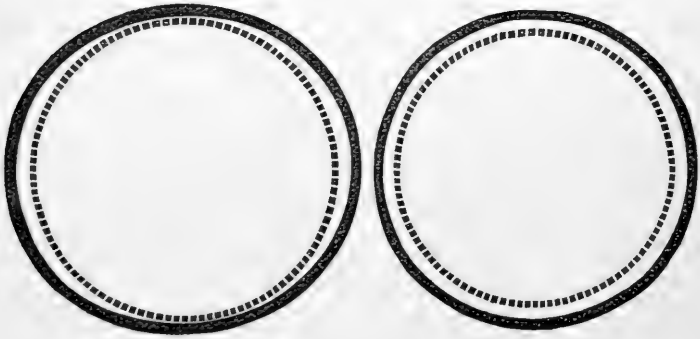
The Schröder prism just invented has several points of excellence, which will win appreciation. It shares with the Wollaston the rare quality that the pencil is seen with equal distinctness in all parts of the field, and that there is no apparent change in the position of the point of the pencil from involuntary oscillation of the head of the draughtsman. I am only sorry to be obliged to say, that I find the usefulness of this neat little instrument is much limited by the very small amount of light it transmits from the object under the Microscope; entailing the condensation of such a body of light by "racking up," when anything like a high power objective is used, as rather to strain the vision and make anything like detail too much a matter of guess. I am encouraged to hope that this condition may be susceptible of modification, and in such case the Schröder prism would not leave much to be desired.

I may just say, that while not appreciating the Abbe prism used for the purpose for which it was constructed, I recognize a most valuable quality which it possesses, for copying drawings and engravings of small area, either of the size of the original or with a slight magnification at will. I think I can see a considerable future for this prism in certain branches of the fine arts.

For the Microscope placed vertically, I will only call attention to one drawing appliance, viz. the "Nachet hooded prism," which you will see I have placed on the ocular of a Microscope in the usual position for sketching. Looking through this prism the image in the Microscope will be seen projected some 5 in. on to the drawing-board placed on the right-hand side. As a prism this has all the advantages and the faults of the class to which it belongs; a very prominent fault being the all but total loss of sight of the image of the pencil when an attempt is made to follow the outline of an object seen between the centre and the outside edge of the field of view—calling the outside that which is apparently farthest away from the microscope-body.

If the drawing-board is placed flat upon the table, you will find that your drawing so made by the Nachet will be much distorted. A good article in our Journal * set me off to experiment on this distortion, and how to get rid of it. I show the satisfactory results arrived at. The boy's head—a cutting from 'Punch'—has been copied twice, in the left-hand picture the drawing-board was flat upon the table. The eye will detect the distortion in a moment, in the head being far too deep from front to back. The right-hand image—taken with the board raised 2 in. at its right-hand end—shows not a trace of distortion. Here is a still more severe test: these (fig. 120) are copies of the circles in Möller's smaller

Fig. 120.

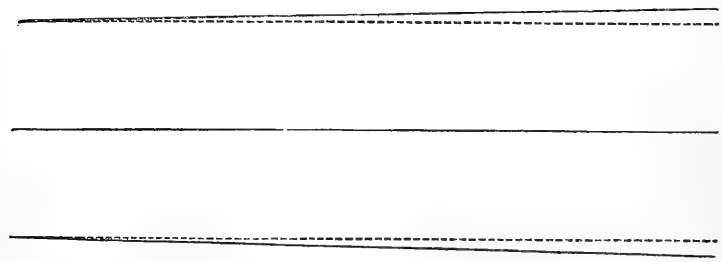


"typenplatte" under the same conditions as to position of drawing-board. The right-hand picture is shown by the dotted circle struck by the compasses to have lost the distortion, which is painfully evident in the one on the left-hand side.

* Vol. III. (1883) p. 560.

In this drawing (fig. 121) of the lines of a fine stage-micrometer, with drawing-board horizontal and inclined, all appreciable

Fig. 121.



distortion has been got rid of by the simple device of raising the right-hand extremity of the drawing-board. Well, this distortion being eliminated, and the loss of sight of the pencil under certain conditions condoned, we must recognize this prism of Nachet as being exceedingly useful and convenient in practice, it being so hinged upon the collar which clasps the ocular, that the optical part can be thrown back like a hood, so as to give a clear view of detail through the ocular only, and the prism can be tilted forward again at will to resume the sketching of outlines with no fear of loss of coincidence with its former position. A tinted glass which can be interposed between the object and pencil respectively, helps to make the Nachet hooded prism a great favourite of mine.

Speaking of this "light-moderator" brings me to the point that one of the great secrets of success in prism drawing from the Microscope is the equalization or balancing of light from object and pencil. The best effect by far is got by two lamps. Where light from the paper is too glaring, as will often happen with the Schröder prism used in daylight, the half-shadow of a curtain allowed to fall upon the paper conduces wonderfully to ease in sketching. I have intimated that with the Schröder prism you may move your head as much as you like, but not so with the other little optical appliances, and this keeping the head steady is as difficult as it is wearisome. Failing an appliance something like a photographer's "head-rest," let me suggest a substitute in a microscope-box, in the position that the left elbow can rest upon it, when the outspread thumb and fingers placed against the forehead will be found to keep the head of the draughtsman fairly steady. A small black velvet curtain, so hung as to touch the microscope-tube just below the ocular, will be found to aid materially in distinctness by cutting off diffused light. You want to see all you can of your object, but make up your mind you will never see

anything like the amount of detail through a prism which you do through the unarmed ocular.

My conviction then is, that the prism has done very much—and indeed all it can do—in enabling you to get rapidly and correctly as a sketch the outlines and salient points of your object under examination, to which your more or less artistic eye will have to supply the detail.

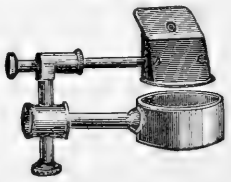
Now to sum up the evidence for the most useful forms of prism:—

At the usual observing angle of the Microscope, and when the object is fairly transparent, Beck or Schröder will do good work, but where there is opacity, then Gundlach is to be preferred, in spite of its inverting the image.

When the Microscope can be placed horizontally, and the objects are suitable, Wollaston's prism gives results of pre-eminent beauty.

With the Microscope vertical, Nachet's hooded prism, I think, stands alone for making copies of almost all objects susceptible of magnification, and it is especially good when dissections are made under the Microscope by aid of an "erector," as the convenient tilting backwards and forwards of the prism allows outlines to be traced, and then dissection to be resumed with the most charming facility.

Fig. 122.



This review of prisms has been a mere outline, but it has taken up all the time I could venture to occupy. While striving to criticize fairly, and placing most stress upon practical points, I have ventured to show what a long and assiduous use of the prism has effected in my hands: permit me to end with the hope that it may do still more in yours.

N.B.—Fig. 122 is a woodcut of the Beck prism, which I believe has not previously been figured.

SUMMARY

OF CURRENT RESEARCHES RELATING TO

ZOOLOGY AND BOTANY

(*principally Invertebrata and Cryptogamia*),

MICROSCOPY, &c.,

INCLUDING ORIGINAL COMMUNICATIONS FROM FELLOWS AND OTHERS.*

ZOOLOGY.

A. GENERAL, including Embryology and Histology of the Vertebrata.

Embryology of the Sheep.† —Dr. R. Bonnet has investigated the earlier stages of development in the sheep embryo.

His positive results commence from the twelfth day after impregnation. Embryos of this age showed round, uniformly bilamellar, germinal vesicles, with a round, bilamellar, embryonic disk of about ·25 mm. in diameter. The epiblast of the disk consisted of two or three layers of cylindrical cells continuous with the flattened ectoblast of the vesicle. The entoblast formed a single distinct layer of cells, distinguishable into two classes, according to position, viz.:—

1. Ovoid cells, beneath the disk.
2. Flat cells, forming a retiform membrane, lining the vesicle generally.

The ovoid cells form "the entoblast of the (future) digestive tract," the flat peripheral cells "the entoblast of the yolk-sac."

On the thirteenth day there appears in the vesicle, peripherally to the disk, a formation of mesoblast in the vesicle. No trace of such a mesoblastic growth is found at this stage in the disk.

Within the disk, mesoblast is formed a little later in a twofold manner. Beneath what eventually is the primitive groove there is formed an ectoblastic "thickening" (*Knoten*). From this is developed the "central" or "ectoblastogenous" mesoblast, which remains in direct and intimate connection with the ectoblast axially. The "peripheral" or "entoblastogenous" mesoblast arises as a peripheral,

* The Society are not to be considered responsible for the views of the authors of the papers referred to, nor for the manner in which those views may be expressed, the main object of this part of the Journal being to present a summary of the papers *as actually published*, so as to provide the Fellows with a guide to the additions made from time to time to the Library. Objections and corrections should therefore, for the most part, be addressed to the authors. (The Society are not intended to be denoted by the editorial "we.")

† Arch. f. Anat. u. Physiol. (Anat. Abtheil.) 1884, pp. 170–230 (3 pls.).

lenticular thickening of the entoblast of the digestive tract, and its cells wander or are thrust in, centripetally, to meet the centrifugal growth of the ectoblastogenous mesoblast. Very soon, however, the production of entoblastogenous mesoblast is observed to take place, not merely at the periphery, but over the whole surface of the entoblast of the digestive tract. Dr. Bonnet concludes that the cells of the mesoblast are to be regarded as mesenchyma in the sense of the Hertwigs.

The primitive thickening of the ectoblast grows caudally to form the primitive streak, whilst the primitive concavity which is hollowed out in it elongates caudally in a similar manner to form the primitive groove.

By the fourteenth day there is a cranial process of the primitive streak, the first "rudiment of the ectoblastogenous chorda."

The formation of the cœlom in the sheep commences peripherally from the disk in the outlying tract of mesoblast, and progresses centrifugally, its proximal limit being formed by the very distinct mesoblast-forming border of the entoblast of the digestive tract, now underlying the growing disk.

The author has found a canal piercing the cranial process of the primitive streak, and placing in (temporary) communication (1) the surface of the epiblastic thickening from which the neural canal is later formed, and (2) the digestive cavity. This canal he identifies with Balfour's neurenteric canal.

The first beginning of the blood-vessels was discovered in the proximal region of the cœlom, external to the embryo, and was seen to arise contemporaneously in both layers of the mesoblast at this point, developing centrifugally at a later period. As both layers of mesoblast are, according to Dr. Bonnet, entoblastic, arising in the first instance at the border of the entoblast of the digestive tract, there is proof of the "indirectly entoblastic origin of the rudiments of the blood-vessels."

Dr. Bonnet promises a further paper on the further development of the sheep's embryo.

Development of the Generative Organs.*—O. Cadiat has an important memoir on the development of the generative organs in the embryos of the sheep and of man. The results are as follows:—

The internal always appear before the external generative structures. The cloacal cavity, which is formed early, commences to divide in embryos of 8 mm. long into an intestinal and genito-urinary portion; but at the lower end of embryos of this age the two are still in communication. When the embryo has attained to 1 cm. in length the separation has advanced somewhat further back, but at the level of the caudal extremity there is always a small common cloacal cavity. In embryos a little older (12 mm.) the genital become partly separated from the urinary passages; it is not until much later (embryos of 6–7 cm.) that the separation between the intestinal, genital, and urinary tubes is complete.

* Journ. Anat. et Physiol., xx. (1884) pp. 212–59 (4 pls.).

The prostate glands are stated by Kölliker to make their appearance at about the third month in the human embryo; in reality, they appear somewhat earlier, about the second month; in a previous investigation carried out in conjunction with M. Robin, it was found that the prostate glands form a system entirely independent of their ducts and of the ejaculatory canals; and the present research confirms this idea; the prostate also is not connected with the urinary apparatus, as it was said to be by Virchow, but with the genital system; it is comparable to the glands of the urethra in the female; the entire urethra in the female is consequently homologous with the prostatic portion only of the male urethra, while the penial portion, including Cowper's glands, corresponds to the vulva in the female.

The external genital organs are fully formed at a somewhat earlier date in the male than in the female; at three and a half months they are very nearly complete in the male, while in the female at this period there is still a slit uniting the urethra with the vagina; a complete separation is accomplished after four months.

Spermatogenesis.*—MM. Swaen and Masquelin have published their very interesting observations on the developmental history of spermatozoa, in continuation of the work of Lavalette St. George. To understand the work of the later observers, it is necessary to recapitulate St. George's conclusions. They are as follows:—Spermatozoa originate in special cells, very similar to young ovules, which may be called *spermatogonia*. These elements multiply and form groups of small cells, *spermatocytes*, which remain grouped together so as to constitute *spermatogems*. At the periphery of the spermatogems a certain number of spermatocytes are modified so as to form a membranous envelope, a cyst (amphibians and insects). In other cases (Selachians), a single spermatocyte is modified at the base of the spermatogem and forms the *basilar cell*. In mammals, on the other hand, the spermatogem developes neither a cystic membrane nor a cystic basilar cell. It is the spermatocytes which are transformed into spermatozoids.

In addition to these elements there occurs a second kind of cell, forming a more or less complete envelope for the spermatogonia. These *follicular cells* play only a very secondary part in spermatogenesis, eventually disappearing.

MM. Swaen and Masquelin conducted their researches on the testicles of *Scyllium catulus*, the salamander, and the bull.

In *Scyllium*, the seminiferous ampullæ of the testicle (cf. Graafian follicles) contain groups of two kinds of cells, (1) the central spermatogonium or *male ovum*, a large nucleolo-nucleate cell partly in contact with the adjacent connective tissue, partly bounded by (2) the smaller, oval or irregularly shaped, follicular cells. As the "male ovule" multiplies (by *indirect* cell-division), the follicular cells also multiply and force their way inwards between the resulting daughter-cells of the spermatogonium to finally form a bilamellar body

* Arch. de Biol., iv. (1883) pp. 749–802 (5 pls.).

composed peripherally of the latter cells and internally of the follicular cells.

The two classes of cells remain throughout perfectly distinct, and Semper is mistaken in thinking that male ovules can be formed from follicular cells.

Cell-division of the male ovules eventually forms bicellular columns of radiating cells. These columns are the *spermatogems*, of which the component cells are the *spermatocytes*. Each spermatogem is proximally capped with a follicular cell, generally crescent-shaped. When each spermatogem consists of six cells this follicular cell makes its way centrifugally between the columns, and attaches itself to the distal end of the spermatogem as the so-called "basilar nucleus" (really a complete and distinct cell).

When this stage has been reached, the remaining follicular cells atrophy and further multiplication takes place in the spermatocytes, the resulting rows of cells (*nematoblasts*) arranging themselves with reference to the axis of the spermatogem (or *nematogem*, as it may now be called) much as the plumules of a feather with reference to the rachis.

A *caudal cavity* is now formed internally in each nematogem, and into this space protrude the "tails" of the resulting spermatozoids. The nematoblasts in their development become rectilinear, and their distal ends eventually form a parallel series, capped by the basilar nucleus. The head of the nematoblast is composed both of nucleus and of cell-protoplasm. The appearance of the nematogem is that of a cone of tapering filaments.

As regards the "problematic body," nothing new was observed.

Eventually the basilar nucleus forms a simple tube surrounding the "sheaf" of spermatozoids, and it is probably by its contractions that these latter are finally expelled.

In the salamander the ampullæ show a cavity, and the follicular cells form an investment for the male ovules. Multiplication and other phenomena occur much as in *Scyllium*.

In mammals the true male ovules are the small parietal cells considered as follicular by Lavalette. These male ovules behave in mammals much as their counterparts in Selachians, &c., except that of the two first products of their division, the one remains inactive for a certain time (*inert male ovule*), whilst the other (*active male ovule*) multiplies by division to form a spermatogem. This peculiarity of mammalian spermatogenesis is due to the continuous production of spermatozoids in the same seminiferous tube.

In conclusion, MM. Swaen and Masquelin institute the following conclusion between cell-development in testicle and ovary:—

1. In the *ovary*, the ovule little by little assumes considerable proportions, the follicular cells multiplying actively to form a continuous envelope, and in some cases to effect the expulsion of the ovule.

2. In the *testicle*, the ovule forms a number of little cells which eventually become spermatozoids. The follicular cells multiply to only a slight extent; more commonly they increase in size (Selachians and salamander).

Factors of Sexuality.*—K. Düsing commences by discussing the correlation of the organs, and reminds us of the familiar fact that agriculturists are in the habit of removing the genital organ from those individual cattle that they wish to fatten. It is next pointed out that in nearly all cases where organs disappear, as for example in parasites, the reproductive apparatus is always retained, while, on the other hand, in sterile hybrids there is a marked development of the organs which preserve the life of the individuals.

With regard to the proportional relations of the sexes, we have some statistical observations; to these the author now adds some considerations from the point of view of the doctrine of natural selection, and he points out that the numerical supremacy of one sex may be of considerable advantage in the development of a large progeny. He thinks, further, that it is possible to demonstrate mathematically that, where there is an abnormal relation of the sexes, an animal which produces a large number of the kind of individuals that are wanting will leave more descendants than one that does not do so. This peculiarity will, in time, be confirmed by natural selection. In illustration of this reference may be made to what seems to be a statistical truth; late fertilization of women tends to the production of males, and, in all circumstances, the first-born are, in the majority of cases, boys. Further, the author believes that statistics show that after a war there is a large preponderance of male babes.

Where, among cattle, demands are largely made on an individual bull, the majority of his progeny are males, and this is because young spermatozoa tend to produce males; this view of the different value of spermatozoa of different ages has the support of so high an authority as Prof. Preyer. Reduced to a general law, the results may be thus enunciated: the larger the want of individuals of one sex, the more frequently are their genital products required, and, therefore, the more frequently do the minority produce young of their own sex. The investigations of Thury have shown that young ova tend to form progeny of the female sex, while delayed fertilization leads to the production of males; the calves of the earlier stages of the rut are more frequently females than those of the later.

The indirect causes which are equivalent to an absence of individuals are (α) insufficient nutrition; the effect of this is seen in the the fact that a well-fed cow served by a starved bull always produces males, and inversely. In other words, there is a close connection between nutrition and reproductive capacity. (β) Difference in age. Every individual at the time of its highest reproductive capacity tends to produce its own sex; and the preponderance of males is greatest when the male is considerably older than the female. This law was discovered by Hofacker and Sadler, and is supported by the 58,000 cases reported on by Goehlert and Legoyt.

We come, then, to this conclusion: Animals have by adaptation acquired the power, in the presence of abnormal sexual relations, of producing more individuals of the sex of which there is a want; and the same balance is maintained by the same methods when there are

* Jenaisch. Zeitschr. f. Naturwiss., xvi. (1883) pp. 428–64.

at work indirect causes which are equivalent to a want of the individuals of one sex.

In another sense the influence of nutriment is of the greatest importance; notwithstanding the fact that a starving animal may reproduce itself numerously, the progeny are feebler than those of one which only produces as many as, under these conditions, can live and thrive. Surplus nutriment leads to the production of a stronger, and insufficient food to that of a weaker progeny. Domesticated animals breed earlier, and are more fruitful than the wild; townsmen and sedentary people more than countrymen who take much hard exercise. More children are conceived in summer than in winter; and in Scotland, according to Haycraft, the maximum of conceptive capacity is simultaneous with that of the thermometer. Birds, bats, and insects breed less numerously than fishes, and especially than parasites who use up little or no force in movement.

The differences we observe between males and females are easily explained when we consider the very different parts that they play in the physiology of reproduction; it must always be remembered that it is the office of the female to produce the material out of which the embryo is built up.

The author concludes by reasserting his conviction that it is in the principle of natural selection that we must look for the explanation of the differences between the sexes.

Rudimentary Placenta in Birds.*—One of the principal distinctions between the Mammalia and the lower Vertebrata has been hitherto supposed to be the possession by the former of a placenta. M. Duval has, however, come to the conclusion that this structure is not exclusively confined to the Mammalia, but that it also exists, though in a rudimentary form, in birds.

The allantois in passing inwards into the pleuro-peritoneal cavity does not become attached to the amnion or to the umbilical vesicle, but joins the chorion, becoming fused with it; it ends by forming a sac which incloses a mass of albumen; into this sac the villi of the chorion project, and an organ is thus formed which is completely analogous to the placenta of the Mammalia; the different form of the organ in birds and in mammals is evidently owing to the difference between the oviparous and viviparous method of reproduction; the villi of the chorion in Mammalia are attached to the body of the mother, while in birds the necessities of the case demand that they should be developed upon the opposite side of the chorion and attach themselves to the nutritive albumen. It is, however, quite intelligible that in an ovoviviparous vertebrate, where the egg has a thin membranous shell, the placentoid organ should become attached to the internal surface of the oviduct. This placenta of birds is therefore a rudimentary organ which enables us to understand how the placenta of the Mammalia may have originated. A physiological difference between the placenta of birds and of Mammalia is that in

* Journ. Anat. et Physiol., xx. (1884) pp. 193-201 (4 pls.). See also this Journal, *ante*, p. 360.

the former the exchange of gases takes place, of course, by the outer surface, so that the two functions of respiration and nutrition are relegated to two different portions of the placenta, while in mammals they both take place on the outer surface of the organ.

Permanence of larval conditions in Amphibia.*—As a general rule the Amphibia when mature cease to breathe by means of gills; the latter disappear and respiration is carried on solely by means of the lungs. There are, however, a number of cases known, and they are increasing daily, where branchial respiration is carried on for a longer or shorter period of the life of the adult. L. Camerano has lately paid some attention to this subject, and has investigated a certain number of these Amphibians, paying special attention to the dimensions of the adult animal, its organs of reproduction, colour, alimentary system, lungs, and nervous system. The period during which branchial respiration continues varies in different Amphibia; the shortest known to him is in *Salamandra atra*, the longest in *Proteus anguineus*, the axolotl, and *Triton*. In almost all the Amphibia of Europe cases are known of an abnormally short or abnormally long "branchiate-period." These may be divided into two classes: (1) those instances of simple hibernation, where the animal has not had time in a single summer to attain maturity; and (2) other cases where the branchiæ remain functional for several years. In this respect, however, the Urodela differ from the Anura; the former are influenced by local conditions, such as food, presence of floods, &c., which render it necessary for them to continue an aquatic life though the development of the other organs of the body goes on quite as rapidly as in individuals that have adopted a terrestrial life. In the Anura, on the other hand, the permanence of the branchiæ for several years is accompanied by an incomplete development of other structures. Such cases are, however, rare, and are not, as in the Urodela, a modification owing to local causes, but are a reversion to an ancestral condition.

The Amphibia as a class are clearly most nearly related to the fish, and the occasional permanence of a branchiate condition is the best proof of this relationship; it is, however, none the less possible that branchiæ were acquired later, and that the Amphibia were primitively land-dwellers, assuming the branchiate condition as a "retrograde metamorphosis" by the adoption of an aquatic life. Keeping in view this possibility it is easy to understand how by artificial interference with the biological conditions, the Amphibia may pass from a branchiate to a pulmonate respiration and back again.

The old division of Perennibranchiata and Caducibranchiata is therefore unphilosophical: the real proof of the adult condition of an Amphibian is the maturity of the reproductive organs, and its branchiate or pulmonate condition must be neglected since it is merely an instance of dimorphism dependent upon the influence of the environment.

* Mem. R. Accad. Sci. Torino, xxxv. (1883) 64 pp. (2 pls.). Naturforscher, xvii. (1884) pp. 273–4.

Embryo Fishes.*—The Bulletin of the United States Fish Commission contains a series of articles upon various matters connected with the development of fishes, embodying the results of the investigations of Mr. J. A. Ryder during the year 1882.

The mode of absorption of the yolk of the embryo shad differs in the absence of a vitelline circulation from that which obtains in *Tylosurus* (*Belone*), *Fundulus*, *Esox*, and *Salmo*. The great mass of the yolk in the shad embryo consists of coarse irregular masses of very clear protoplasmic matter, separated by a protoplasm which is optically different. The covering of the yolk is a palish amber-coloured layer, quite different from the clear body of the yolk, and usually thicker at the end next the heart. The intestine lies in a longitudinal furrow on the dorsal aspect of the yolk-sac, and is never connected with it in this species. The yolk-sac is surrounded by a space filled with serous fluid. This space is capacious anteriorly, between the heart and the yolk, and this part is identified by the author with the segmentation-cavity. The delicate pericardial membrane that separates this cavity from the pericardial space may, possibly, be perforated. In *Tylosurus* the two cavities are certainly connected. The heart opens freely into the segmentation-cavity, and the appearance presented is that its persistent pulsation breaks up the yolk-substance into small spherules, sucks them out of the segmentation-cavity, and carries them into the body of the embryo. The corpuscles develope on the surface of the outer yolk-layer, and after a while drop into the serous fluid, appearing like the white blood-cells of human blood. As development proceeds, the yolk-sac becomes pointed in front, and the external layer becomes thicker, while the pericardial membrane becomes funnel-shaped to fit the anterior part of the yolk-mass. Before the final disappearance of the yolk, the liver of the young fish becomes more developed, and the portal vein makes its way over the dorsal aspect of the yolk towards the venous end of the heart. As the peculiar amber-layer around the yolk persists to the last, it is probable that the central clear portion is transformed gradually into it.

This is the history of the yolk-mass after the embryo is hatched, but as it grew in size before hatching, yolk-absorption must have taken place before the heart was sufficiently developed to be an active agent in the process. This must be by intussusception, and in the amber yolk-covering it is undoubted that a process of cell and blood-cell differentiation takes place. Mr. Ryder concludes that the hypoblast of Gensch, said by that investigator to be the source from which the blood is derived, is the equivalent of the amber yolk-covering of the shad, and not the true hypoblast. This amber layer is a temporary structure, which disappears entirely, and does not enter into the formation of any organ or membrane. The serous cavity around the yolk in the shad represents the body-cavity, and the outer covering of this, though only 1/2000 of an inch in thickness, contains epiblast, mesoblast, and hypoblast.

* Bull. U.S. Fish Commission—Observations on the Absorption of the Yolk, the Food, Feeding and Development of Embryo Fishes, &c., pp. 179-205. Amer. Natural., xviii. (1884) pp. 395-8.

There is practically little difference between the modes of yolk-absorption in the chick and in the fish.

The author brings forward facts to prove that there is between ova, even of allied genera, considerable differences, and that at no stage is there a positive identity.

The mechanical construction, as it may be termed, of ova affects the course of their development. The Teleost ovum has a relatively enormous yolk, which must be included by the blastoderm in order to be absorbed, and this relatively large yolk has much to do with the difference observed between its development and that of a Marsipobranch or Amphibian. The eggs of the Salmonidæ have an abundance of oil-drops in the vitellus, especially just under the germinal disk. These by their buoyancy keep the disk constantly directed upward. The cusk, the crab-eater, Spanish mackerel, and moon-fish have eggs which are buoyant from the possession of a single large oil-sphere situated almost exactly opposite to the germinal disk, and thus keeping it face downwards—just the reverse of what occurs in the Salmonoids. Even after hatching, the young are at first unable to right themselves on account of the presence of the oil-drop. The cod ovum has no oil-drop, yet floats with the germinal disk downwards. That of *Morone Americana* (white perch) is adhesive and fixed with a very large oil-sphere, which keeps the disk on the lower side of the vitelline globe. The shad egg is non-adhesive, and heavier than water, and the germinal disk has a constant tendency to arrange itself at the side of the vitellus as viewed from above, though there is no oil to influence it. In *Fundulus* and *Syngnathus* the oil-drops appear uniformly distributed. The number of proto-vertebræ or primary somites differs so much that while *Tylosurus* has so many as seventy-five pairs, *Alosa* has only eighteen to twenty. The author ventures this bold remark: "When our knowledge is more complete, we shall perhaps be able to distinguish the species apart by the eggs alone, just as botanists have used the characters presented by seeds to distinguish plants."

Development of Viviparous Minnows.*—J. A. Ryder describes the development of viviparous minnows, and particularly *Gambrusia patruelis* B. and G. The young fish develope within the body of the female parent, and within the follicles in which the eggs themselves are developed. The follicles, which are covered with a rich network of fine capillary vessels, assume the office of a respiratory apparatus, by which the gases are interchanged between the embryo and the parent fish. This follicle also acts as an egg-membrane, being actually perforated by a round opening ("follicular pore") which is analogous to the micropyle of the ordinary fish-egg. The arrangement of the follicles of the ovary within the body of the female is described, and the peculiar differences between the two sexes in the arrangement of the viscera pointed out. The fibrous bands, which act as supports or stays to the basal portion of the anal fin of the male, which is modified as an intromittent organ, are also described.

* Science, iii. (1884) p. 769.

The great difference in the sizes of the sexes is also referred to, the female weighing over six times as much as the male.

Formation of and Reactions of Nuclei.*—C. Frommann finds that the application of acids to nuclei of non-amœboid cells does not result at first in a great change in the yellowish granules of the protoplasm, but that, after the acids have acted for some time, they become pale and can no longer be accurately distinguished from one another, and the nucleus appears to be surrounded by a distinct membrane. With amœboid cells the action of acids results in the appearance of a firm stroma and a firm more complete investing membrane; from the material of the protoplasmic granules new nuclei as well as separate longer filamentar structures are formed, or granules only are formed, and the protoplasm becomes clearer and more homogeneous. It must be borne in mind that we have here to do with artificial products. The author criticizes the views of Robin, and points out that structures, which we are bound to compare with nuclei, are to be found in the living colourless blood-corpuscles; this has been proved by Stricker for non-defibrinated, and by Frommann for defibrinated blood, and Flemming speaks very positively as to the presence of nuclei in living leucocytes, whether in or out of the vessels of the larvæ of the salamander.

If a homogeneous body, either spontaneously or after the action of chemical or physical reagents, differentiates into a formed and a homogeneous substance, the phenomenon may be explained by the supposition that both bodies were present, but had the same refractive index, or by supposing that the apparently homogeneous body was really so, and that the appearance of formed elements is due to a differentiation of its substance into elements which are more highly refractive, and a clear substance which fills up the interspaces. The author is inclined to accept the latter view as applying to what obtains with nuclei, and supports it by various considerations. Experiments with salt solutions show that, after the fusion of the whole mass of the grains and granules with the nucleus, the whole structure thus formed becomes converted into a nucleus with sharply defined stroma and firm investment, so soon as spring or distilled water is added to the preparation. Various other experiments are detailed, the study of which is a matter of great importance for those who are making observations or experiments in connection with the phenomena exhibited by nuclei.

Indirect Nuclear Division.†—E. Strasburger commences an essay on the subject of the controversy with regard to indirect nuclear division by an account of some specimens of the embryonic sac of *Fritillaria imperialis*, which had been prepared by Herr Heuser. He concludes from his numerous observations that it is very probable that in all typical processes of the indirect division of the cell-nuclei of plants there is a stage in which the segments of the nuclear filament divide longitudinally. This process is not, however, always

* SB. Jenaisch. Gesell. f. Med. u. Naturwiss., 1883 (1884) pp. 4–16.

† Arch. f. Mikr. Anat., xxiii. (1884) pp. 246–304 (2 pls.).

found to be associated with the same definite arrangement of the segments in the nucleus, and it may either precede or succeed the arrangement of the segments into the nuclear plate.

If we compare what is now known as regards plants with the results of studies on the division of the nuclei of animals we find that, with one exception, there is really no important difference between them. The investigation of plants shows that the spindle-shaped fibres almost certainly arise from compressed cytoplasm. The whole framework of the nucleus is to be found in the filamentar coils, while the nuclear cavity is only filled by homogeneous nuclear fluid. The whole mass of spindle-shaped fibres have their origin in the cytoplasm.

The difference in the way in which cell-division is completed is a point of distinction between animals and plants, but it does not obtain in the lowest forms of either kingdom. The formation of the connective filaments in the separation of the cell-body is a distinctive characteristic of plants; but, notwithstanding this, the result of cell-division is the same in both plants and animals.

In both we find that in the "prophases" of nuclear division cytoplasm is collected at the future poles of the cell-nucleus; this phenomenon is often very striking in animal-cells, and is especially well marked in ova. The nucleus becomes provided with two radiating systems, even before any dicentric arrangement can be detected in the cell-nucleus. The observations which the author has made lead him to think that the spindle-shaped fibres derived from the cytoplasm have a directive influence on nuclear division; the frequently simultaneous division of nuclei in multinucleated cells may be easily supposed to be due to this influence and the surrounding cell-plasma.

Strasburger thinks that some of the aberrant forms of division noted by Flemming may be explained by what he has seen in plants. The tub-shaped figures which become apparent during the arrangement of the segments in the testicular epithelium of the salamander call to mind what was seen in the embryo-sac of *Fritillaria*, and suggests that an explanation is to be found in the divarication of the daughter-segments on one side, and their approximation to one another on the other. In the red blood-cells of *Salamandra* the cell-nucleus becomes considerably enlarged during the development of the filamentar coil, and a large amount of cell-substance is taken up into the nuclear figure. If the spindle-shaped fibres form only a small figure in the cell, it would be clear that all the cytoplasm was not used up in forming this figure, and we should have a case similar to that seen in the pollen-mother-cells of *Fritillaria persica*, where in the first act of division granular cytoplasm is found between the spindle-shaped fibres.

The ideas now derived from a study of animals and plants cannot be directly applied to the Protista, where the separate parts of the cell-body often undergo great changes and become adapted to new functions; we must greatly increase the number of our observations before we can hope to arrive at generalizations of universal value.

The function of the complicated nuclear division appears to be that of dividing the nucleus into two completely equal halves; in the first segmentation the parts are often very unequal in size, and if, as Heuser supposes, there are several different substances in the disks of the microsomes longitudinal division would be the safest means for distributing the substances equally to the two daughter-nuclei. It is quite clear that the nucleus has a nutrient function for the cell, though we do not yet know what its character is. In the internodes of the Characeæ we see the nucleus increasing in proportion to the mass of the increasing cytoplasm, although here cell-division does not accompany nuclear division; here indeed direct division of the nucleus (by constriction) takes the place of indirect division.

Nucleus of the Auditory Epithelium of Batrachians.*—The results of J. Chatin have a double interest, as affording us more complete information as to several points in the comparative histology of the auditory epithelium, and as bearing on the structure of the nucleus.

The study of the epithelial layer which invests the labyrinths of Batrachians demonstrates a close relationship between the sustaining and sensitive elements; they are intimately connected, and they undergo the same kind of modifications. What is true of Batrachians is true also of other vertebrates; in the Mammalia, for example, there are auditory rods and ciliated cells, but between the two all intermediate stages are to be made out, and this even at some single point.

As to the intranuclear corpuscles the author finds that, so soon as they have acquired their definite characters and become grouped in a plexus they are all perfectly identical; there is no trace of any nucleolus. In insects, Chatin has noted the inconstant character of the nucleoli, and Klein, working at certain glandular elements of the Batrachia, likewise bears witness to their absence.

Epidermis of the Chick.†—C. Frommann has examined the epidermis of the chick during the last week of its stay in the shell, and finds in it granular cells and net-cells; the former are rounded or oval and contain granules which are fused into cords of various forms; these are connected with one another by filaments of various degrees of fineness, which traverse the delicate spaces left between them; here and there, however, there are larger spaces. In neither case have the spaces any special wall. The body of the net-cell is traversed in all directions by a wide-meshed network; part contains neither nuclei nor any aggregations of cell-substance, while in other parts the nodal points have nuclei. On the whole, the characters of the cells of the epidermis are the same as after the period when the chick leaves the egg. Certain differences are presented in the parts of the skin which are feathered, for there is there ordinarily a layer of small granules imbedded in a pale, finely granular substance, in which nuclei are either completely absent or are irregularly scattered

* Ann. Sci. Nat. (Zool.), xvi. (1884) 5 pp.

† Jenaisch. Zeitschr. f. Naturwiss., xvii. (1884) pp. 941–50.

about; such nuclei are always small and vary in character. Schenk has already noted the presence of non-nucleated cells in the ectoderm when describing the process of fusion of the folds of the amnion.

Scales, Feathers, and Hairs.*—The idea largely taught to students that scales, feathers, and hairs are identical in nature is combatted by J. E. Jeffries. He considers the epiderm to be the primitive skin, if not the true one, as it is formed long before the corium, which is a late and very variable product of the mesoblast; and because all the organs of sense are formed from it. The epiderm may be regarded as primitively consisting of a smooth mucous layer, an epitrichial layer, and perhaps an intermediate layer of parenchymatous cells. In birds and mammals the outer layer is lost, and never renewed, while the middle layer becomes thickened and subject to various modifications, as drying, conversion into horn, &c., and enters into the structure of all the appendages. Scales are moulted and renewed, scuta are not. The toe-pads of birds may be seen to pass over into scuta on the sides of the toes of many birds. Scuta bear feathers as epidermal appendages—scales never do, thus pointing to scuta, which have a mucous layer and outer horn coat with a mesodermal core, as simple folds of the skin, not as appendages.

The early stages of a feather and of a hair differ. The latter is formed in a *solid* ingrowth of the epiderm, the latter from the epiderm of a large papilla. A hair does not contain any of the mucous cells, while a considerable portion of a feather consists of them. The supposed homology between feathers and scales seems to fail before the facts that the mucous layer is absent in the latter, and that Studer has shown that the imagined scale-like nature of the remiges of penguins is a fallacy. Mr. Jeffries avows his belief in the distinct origin of the dermal appendages of the higher vertebrates, and asserts that the nakedness of the Amphibia is a strong argument against the identity of any of the avian appendages with those of reptiles and mammals.

Locomotion of Animals over smooth Vertical Surfaces.†—Dr. H. Dewitz has extended his observations on this subject, at first confined to insects,‡ to a variety of other forms, including some Vertebrata. He finds that the same means, the exudation of a secretion, are adopted in many cases, even where sucking-disks are used. Thus the leech can walk on a wire network, on which the disks could not act by exhaustion of the air, and the secretion of the disks of *Piscicola* has been examined by Leydig. A long series of animals is enumerated from Worms and Echinoderms to Apes among the Mammalia, which are known with more or less certainty to use similar means for climbing.

The tree-frog (*Hyla*) maintains its hold as firmly within the exhausted receiver of an air-pump as in the open air, and in fact a piece of glass passed over the balls of the tips of the toes shows clear

* Proc. Bost. Soc. Nat. Hist. Cf. Amer. Natural., xviii. (1884) p. 640.

† Pflüger's Arch. gesammt. Physiol., xxxiii. (1884) pp. 440–81 (3 pls.). See also *infra*, Insecta.

‡ See this Journal, iii. (1883) p. 363.

traces of the secretion. If studied by sections, the ball of the foot exhibits on the upper surface some globular mucous glands imbedded in the cutis, and some elongated glands, imbedded in the connective tissue, on the lower side; this is the case on the balls of all the phalanges. In *Rana temporaria*, too, these dermal glands have a similar form, only being less numerous and long; they probably serve a similar function.

The glands in *Hyla* are tubular, there is a *tunica propria*, and the cells are longish and somewhat cubical in longitudinal, but mostly hexagonal in transverse section; the nucleus, which is the only part which is stained readily by picrocarmine, lies at the lower end; the cells end distally in two pointed processes. The glands do not open in the annular furrow, but over the whole of the sole, especially at the hinder part; the ducts are lined by a cuticle which is shed with the skin. The spongy connective tissue of the ball of the toe is filled with lymph, and is thus rendered elastic, so that it adapts itself to inequalities of surface; balls of similar structure are found on the tarsal joints of Orthoptera. By fastening insects feet uppermost on the under side of a covering-glass which projects from a glass slide, the hairs which clothe the grasping lobes of the foot may be seen (e. g. in *Musca erythrocephala*) to be tipped with drops of transparent liquid. On the leg being drawn back from the glass, a transparent thread is drawn out, and drops are found to be left on the glass.

The grasping apparatus is constructed as follows: The short grasping foot-hairs in *Telephorus* and other Coleoptera are each traversed by a canal which opens at its extremity. Sundry long hairs on the lower side of the tarsal joints in *Telephorus* are connected with nervous filaments which lead from small ganglia, and thus constitute tactile organs. The observation of what appear to be nerve-fibres in the glands which supply the hairs with the sticky secretions is not sufficiently certain.

In the Orthoptera the arrangement is different: thus the tarsus of a Locustid has the chitinous covering of the lower side rendered very flexible by being composed of small parallel tubes, the underlying matrix is deeply plicate, and constitutes a large gland, whose secretion is transmitted through the chitinous tubes and through another intermediate chitinous layer to the surface. In the house-fly, the grasping foot-lobes appear to be only called into play when the insect has to walk on vertical smooth surfaces, for in other cases they hang loosely down. So also the Echinoidea use the tube-feet only on vertical surfaces.

The use of a glutinous secretion for walking has been shown by Burmeister for Dipterous larvæ; Dr. Dewitz finds the larva of a *Musca* to use for the purpose a liquid ejected from the mouth. Thus, too, the larvæ of *Leucopis punctipennis* accomplish their loop-like walk—the liquid in this case comes from both mouth and anus. A *Cecidomyia*-larva is able to leap by fixing its anterior end by means of a liquid of this kind. The larva of the alder-leaf beetle (*Galeruca*) moves by drawing up its hinder end, fixing it thus, and carrying the

anterior part of the body forward with its feet until fully extended, when it breaks the glutinous adhesion; under even the lower powers of the Microscope the drops of secretion may be seen on the feet. A *Chrysopa*-larva (probably *Hemerobius*) was able to crawl well on vertical glass, but on sand the feet became clogged; some larvæ of this group, on the other hand, had the grasping lobes but slightly developed, and these adopted the loop mode of walking; the adhesion of the posterior end of the body was so strong that many larvæ long resisted all attempts to shake them off by twisting the glass suddenly round.

Among the Hymenoptera the ventral feet of some sawflies have this power. Most spiders are devoid of it, but leaping spiders leap and crawl on vertical surfaces, and have grasping disks for adhesion. Among Cœlenterata, *Hydra* may be seen to excrete mucous adhesive matter from its foot.

Zoology of the Voyage of the 'Alert.'*—The Zoological collections made by Dr. R. W. Coppinger, Staff-Surgeon H.M.S. 'Alert' in the Melanesian Seas and in the Western Indian Ocean were so large that the Trustees of the British Museum ordered the account of them to be published as a separate volume. The magnitude of the collection may be inferred from the statement that "irrespective of a number of specimens set aside as duplicates not less than 3700 referable to 1300 species were incorporated in the National Collection;" of these the most important were marine invertebrates, and 490 of the species are either new or are additions to the Museum. The specimens were admirably preserved, and collected, Dr. Günther says, with singular judgment.

In place of the one species of lancelet which Dr. Günther thought to be cosmopolitan, six distinct species are, he now thinks, to be recognized.

The Mollusca are treated of by Mr. Edgar A. Smith, who finds that of the Melanesian specimens the general character is Malayan.

The Echinodermata are dealt with by Prof. F. Jeffrey Bell, who found that 30 of the 124 Melanesian species were new; fifteen of these were Comatulids. He adduces evidence to show that pattern of coloration is not as important a characteristic of the species of *Ophiothrix* as has been generally supposed. He proposes some alterations in the mode of formulating the characters of Crinoids. Having had the opportunity of examining a large collection from the Sydney Museum he finds that no view can be more erroneous than one which speaks of an Australian (marine) fauna without some sort of qualification; Cape York and Port Molle are as much part of Australia as Port Jackson, but between the two faunæ the resemblance is as slight as is in the nature of things possible. He concludes, in fact, that "to-day, as in those Tertiary times when a wider sea separated the Australian from the Asiatic continent, there are forms whose breadth of range is coincident rather with isothermal lines than with topographical boundaries." The marked manner in which the species

* 'Report on the Zoological Collections made in the Indo-Pacific Ocean during the voyage of H.M.S. Alert, 1881–2.' 8vo, London, 1884, 684 pp. (54 pls.).

of Crinoids vary among themselves leads to the hope that the details of the tropical fauna may be elucidated by their aid.

Similarly, according to Mr. Miers, the Crustacea collected have one-third of their species widely distributed through the Indo-Pacific region; the affinity of the Australian with the European Amphipoda is very remarkable, some of the species being identical. Mr. Miers gives a very elaborate table of the distribution of the higher Crustacea on the East Coast of Africa and the adjacent islands.

Mr. S. O. Ridley deals with the Alcyonaria and Spongiidæ; of the former there are 38 Melanesian species, and the author thinks that few novelties are in the future to be expected from the shallow water; one-third of the Alcyonaria are new to science; *Psilacabaria* is a new genus of Melithæids, and its species is remarkable for the large size of its spicules. Thirty-eight per cent. of the Melanesian sponges are certainly new to science; the greater number of novelties belong to the Ceratosa; as to individual variation, it is noted that this often affects the size of the spicules; variation in form of the spicules is less common, that of external form is sometimes very striking. Only a quarter of the species of sponges are known to occur outside the Australian seas; the most widely ranging are the most generalized, but in some cases it is possible that the same specific characters have been independently acquired. Twenty-eight per cent. of the sponges obtained in the Western Indian Ocean were found to be identical with those of the Australian Seas. The most striking point with regard to the sponges appears to be "the comparative scarcity of forms showing marked distinctive characters of generic importance which are not also found in the more familiar Atlantic fauna."

B. INVERTEBRATA.

Origin of Fresh-water Faunæ.*—Prof. W. J. Sollas points out that the poverty of fresh-water faunæ, as compared with marine, is commonly attributed to a supposed inadaptability on the part of marine organisms to existence in fresh water. That this is erroneous is shown by the existence of fresh-water jelly-fish such as *Limnocodium*, and still more directly by the experiments of Beudant, who succeeded in accustoming several kinds of marine mollusca to a fresh-water habitat. The view of Von Martens that the severity of a fresh-water climate is prohibitive of the existence of most marine forms in rivers is insufficient, and a more thorough-going explanation is necessary. This is to be found in a study of the means by which the distribution of marine animals is secured.

In the case of stationary forms, free-swimming embryos are distributed over wide areas by currents, and they can never pass from the sea into rivers, in which the current is always directed seawards. Nor, probably, could an attached form once introduced into a river permanently establish itself so long as its propagation took place exclusively through free-swimming larvæ, for these would be gradually borne

* Nature, xxx. (1884) p. 163.

out to sea. Hence, fresh-water animals should not, as a rule, pass through a free larval stage of existence, nor, as a matter of fact, do they. In *Hydra*, fresh-water sponges, and Polyzoa, the young usually emerge from a horny cyst in the complete state. In the Unionidæ, the glochidium-stage provides for distribution without involving a seaward journey. The young of fresh-water molluscs do not enter upon a free existence till they are similar to their parents, and *Paludina* is viviparous. The suppression of a free-swimming larval stage not only occurs in fresh-water, but in many marine invertebrates.

This is connected with the fact that the larval stage is in a position of disadvantage as compared with the adult. Hence there is an advantage to the organism if the larval stage can be passed over in a state of seclusion. From this various other modifications follow; development in seclusion involves a supply of accessible food, hence the appearance of yolk and other kinds of nourishment furnished by the parent to the imprisoned embryo. Again, the secluded larva being spared the drudgery of working for its own existence, and supplied with nutriment in a form that puts the least tax on its digestive powers, a larger balance of energy remains available for metamorphic changes. Thus arise the phenomena of accelerated and abbreviated development. Further, the shortening of the larval life probably leads to the lengthening of the adult life, and shifts the chances of variation and selection forward into the adult stage. Thus, animals which hatch out in a complete state will most probably suffer modifications of that, and not of previous ones, except very indirectly. Here we discover a direct tendency towards a mode of development which explains the "arborescent" character of our zoological classifications, i. e. the tendency of the tree of life is now to produce leaves rather than new branches. In the case of fresh-water faunæ very direct reasons have existed for the suppression of the free larval stage. In this connection may be noticed the richness in species and the poverty in genera of the fresh-water mollusca.

In discussing the origin of fresh-water faunæ there are three hypotheses from which we have to select: (1) that marine forms have migrated into rivers; (2) that they have migrated into marshes, and thence into rivers; and (3) that marine areas have been converted into fresh-water ones. The last course has been the most usual, especially in the case of non-locomotive forms. Hence the origin of fresh-water invertebrates is connected with the great movements which have affected the earth's crust.

Pelagic Fauna of Fresh-water Lakes.*—O. E. Imhoff first deals with the "Langensee," and refers to the remarks of Crisp as to the synonymy of some of his species with those previously described by Gosse, pointing out certain errors or lacunæ in Gosse's descriptions. Dealing with the pelagic fauna of four of the lakes of northern Italy he adds to them one Flagellate, *Dinobryon divergens* Imhoff, a species of *Ceratium*, *Conochilus volvox*, *Anuræa cochlearis* and *longispina*, *Asplanchna helvetica*, and a species of *Polyarthra*. Among the

* Zool. Anzeig., vii. (1884) pp. 321–7.

Cladocera we have *Bythotrephes longimanus* of Leydig and a species of *Daphnia*.

The pelagic fauna of fresh-water lakes consists of genera which, like *Piscicola* or *Argulus*, are occasionally found there, and others which do not voluntarily leave it; the latter are divisible into such as live on true pelagic animals or plants, like *Acineta*, *Vorticella*, and *Epistylis*, and others which are truly pelagic (*Eupelagici* Pavesi), such as the genera referred to above and *Bosmina* and *Leptodora*.

Lowest and Smallest Forms of Life as revealed by the modern Microscope.*—The following are some of the principal passages of the lecture delivered by the Rev. Dr. W. H. Dallinger, at the Montreal meeting of the British Association. The 'Times' says † of it, "But, perhaps, the most popular and most generally instructive feature in connection with biology at Montreal was the address of Dr. Dallinger, in which he exhibited by word and picture the wonderful revelations of the lowest forms of life made by the modern Microscope; and in which he showed that however easy it may seem to be to generate life in the proper conditions, no one has ever yet succeeded in producing 'spontaneous generation.' And here Dr. Dallinger is in accord with the most competent scientific opinion."

Dr. Dallinger said:—"The labour, enthusiasm, and perseverance of thirty years, stimulated by the insight of a rare and master mind, and aided by lenses of steadily advancing perfection, has enabled the student of life-forms not simply to become possessed of an inconceivably broader, deeper, and truer knowledge of the great world of visible life, of which he himself is a factor, but also to open up and penetrate into a world of minute living things so ultimately little that we cannot adequately conceive them, which are, nevertheless perfect in their adaptations and wonderful in their histories. These organisms, while they are the least, are also the lowliest in nature, and are totally devoid of what is known as organic structure, even when scrutinized with our most powerful and perfect lenses. Now, these organisms lie on the very verge and margin of the vast area of what we know as living. They possess the essential properties of life, but in their most initial state. And their numberless billions, springing every moment into existence wherever putrescence appeared, led to the question, How do they originate?—do they spring up *de novo* from the highest point on the area of not-life which they touch? Are they, in short, the direct product of some yet uncorrelated force in nature, changing the dead, the unorganized, the not-living into definite forms of life?

Now this is a profound question, and that it is a difficult one there can be no doubt. But that it is a question for our laboratories is certain. And after careful and prolonged experiment and research, the legitimate question to be asked is: Do we find that in our laboratories and in the obscured processes of nature now that the not-living can be, without the intervention of living things, changed into that which lives? To that question the vast majority of practical

* 'Times,' 2nd September, 1884. † Ibid., 4th September, 1884.

biologists answer without hesitancy, 'No, we have no facts to justify such a conclusion.' Professor Huxley shall represent them. He says: 'The properties of living matter distinguish it absolutely from all other kinds of things;' and, he continues, 'the present state of our knowledge furnishes us with no link between the living and the not-living.' Now let us carefully remember that the great doctrine of Charles Darwin has furnished biology with a magnificent generalization—one, indeed, which stands upon so broad a basis that great masses of detail and many needful interlocking facts are of necessity relegated to the quiet workers of the present and the earnest labourers of the years to come. But it is a doctrine which cannot be shaken. The constant and universal action of variation, the struggle for existence, and the 'survival of the fittest,' few who are competent to grasp will have the temerity to doubt. And to many, that which lies within it as a doctrine and forms the fibre of its fabric, is the existence of a continuity, an unbroken stream of unity running from the base to the apex of the entire organic series. The plant and the animal, the lowliest organized and the most complex, the minutest and the largest, are related to each other so as to constitute one majestic organic whole. Now, to this splendid continuity practical biology presents no adverse fact. All our most recent and most accurate knowledge confirms it.

But the question is—Does this continuity terminate now in the living series, and is there then a break—a sharp, clear discontinuity, and beyond, another realm immeasurably less endowed, known as the realm of Not-life? Or, does what has been taken for the clear-cut boundary of the vital area, when more deeply searched, reveal the presence of a force at present unknown, which changes not-living into the living, and thus makes all nature an unbroken sequence and a continuous whole? That this is a great question, a question involving large issues, will be seen by all who have familiarized themselves with the thought and fact of our times. But we must treat it purely as a question of science; it is not a question of how life first appeared upon the earth, it is only a question of whether there is any natural force now at work building not-living matter into living forms. Nor have we to determine whether or not, in the indefinite past, the not-vital elements on the earth, at some point of their highest activity, were endowed with or became possessed of the properties of life. On that subject there is no doubt. The elements that compose protoplasm—the physical basis of all living things—are the familiar elements of the world without life. The mystery of life is not in the elements that compose the vital stuff. We know them all; we know their properties. The mystery consists solely in how these elements can be so combined as to acquire the transcendent properties of life. Moreover, to the investigator it is not a question of by what means matter dead—without the shimmer of a vital quality—became either slowly or suddenly possessed of the properties of life. Enough for us to know that whatever the power that wrought the change, that power was competent, as the issue proves. But that which calm and patient research has to determine is, whether matter

demonstrably not living can be, without the aid of organisms already living, endowed with the properties of life.

Judged of hastily and apart from the facts, it may appear to some minds that an origin of life from not-life, by sheer physical law, would be a great philosophical gain, an indefinitely strong support of the doctrine of evolution. If this were so, and indeed so far as it is believed to be so, it would speak and does speak volumes in favour of the spirit of science pervading our age. For although the vast majority of biologists in Europe and America accept the doctrine of evolution, they are almost unanimous in their refusal to accept, as in any sense competent, the reputed evidence of 'spontaneous generation': which demonstrates at least, that what is sought by our leaders in science is not the mere support of hypotheses, cherished though they may be, but the truth, the uncoloured truth, from nature. But it must be remembered that the present existence of what has been called 'spontaneous generation,' the origin of life *de novo* to-day by physical law, is by no means required by the doctrine of evolution. Prof. Huxley, for example, says, 'If all living beings have been evolved from pre-existing forms of life, it is enough that a single particle of protoplasm should once have appeared upon the globe, as the result of no matter what agency; any further independent formation of protoplasm would be sheer waste.' And why? we may ask. Because one of the most marvellous and unique properties of protoplasm, and the living forms built out of it, is the power to multiply indefinitely and for ever!

What need, then, of spontaneous generation? A locomotive on a great journey, that is specifically endowed with the power to generate its own steam, surely does not need stationary engines placed all along the line to generate steam for it. It is certainly true that evidence has been adduced purporting to support, if not establish, the origin in dead matter of the least and lowest forms of life. But it evinces no prejudice to say that it is inefficient. For a moment study the facts. The organisms which were used to test the point at issue were those known as septic. The vast majority of these are inexpressibly minute. The smallest of them, indeed, is so small that 50 millions of them, if laid in order, would only fill the one-hundredth part of a cubic inch. Many are relatively larger, but all are supremely minute. Now, these organisms are universally present in enormous numbers, and ever rapidly increasing—in all moist putrefaction over the surface of the globe." Referring to an experiment made with a few shreds of fish muscle and brain in pure water, and which in a brief space gave rise to a multitude of many living and moving organisms, Dr. Dallinger asked, "How did these organisms arise? The water was pure; they were not discoverable in the fresh muscle of fish. Yet in a dozen hours the vessel of water is peopled with hosts of individual forms which no mathematics could number! How did they arise—from universally diffused eggs, or from the direct physical change of dead matter into living forms?

Twelve years ago the life-histories of these forms were unknown. We did not know biologically how they developed. And yet with

this great deficiency it was considered by some that their mode of origin could be determined by heat experiments on the adult forms. Roughly the method was this. It was assumed that nothing vital could resist the boiling point of water. Fluids containing full-grown organisms in enormous multitudes, chiefly bacteria, were placed in flasks, and boiled for from 5 to 10 minutes. While they were boiling the necks of the flasks were hermetically closed, and the flask was allowed to remain unopened for various periods. The reasoning was: Boiling has killed all forms of vitality in the flask. By the hermetical sealing nothing living can gain subsequent access to the fluid; therefore, if living organisms do appear when the flask is opened, they must have arisen in the dead matter *de novo* by spontaneous generation. But if they do never so arise the probability is that they originate in spores or eggs. Now it must be observed concerning this method of inquiry that it could never be final; it is incompetent by deficiency. Its results could never be exhaustive until the life-histories of the organisms involved were known. And further, although it is a legitimate method of research for partial results, and was of necessity employed, yet it requires precise and accurate manipulation. A thousand possible errors surround it. It can only yield scientific results in the hands of a master in physical experiment. And we find that when it has secured the requisite skill, as in the hands of Prof. Tyndall for example, the result has been the irresistible deduction that living things have never been seen to originate in not-living matter. Then the ground is cleared for the strictly biological inquiry, How do they originate?

To answer that question we must study the life-histories of the minutest forms with the same continuity and thoroughness with which we study the development of a crayfish or a butterfly. The difficulty in the way of this is the extreme minuteness of the organisms. We require powerful and perfect lenses for the work. Happily during the last fifteen years the improvement in the construction of the most powerful lenses has been great indeed. Prior to this time there were English lenses that amplified enormously. But an enlargement of the image of an object avails nothing if there be no concurrent disclosure of detail. Little is gained by expanding the image of an object from the ten-thousandth of an inch to an inch, if there be not an equivalent revelation of hidden details. It is in this revealing quality, which I shall call magnification as distinct from amplification, that our recent lenses so brilliantly excel. It is not easy to convey to those unfamiliar with objects of extreme minuteness a correct idea of what this power is. But at the risk of extreme simplicity, and to make the higher reaches of my subject intelligible to all, I would fain make this plain." Dr. Dallinger then went on to give a series of greatly magnified illustrations, beginning with the sting of the bee, and going on through a long series of interesting specimens of the lowest forms of life. He described and illustrated with great minuteness experiments in the generation of these forms of life, from all of which he maintained it to be clearly proved that dead matter cannot be developed into living.

"We conclude," he said, "with a definite issue—viz. by experiment it is established that living forms do not now arise in dead matter. And by study of the forms themselves it is proved that, like all the more complex forms above them, they arise in parental products. The law is as ever, only the living can give rise to the living."

Intelligence in the Lowest Animals.*—"No one," writes Dr. G. J. Romanes, "can have watched the movements of certain Infusoria without feeling it difficult to believe that these little animals are not actuated by some amount of intelligence. Even if the manner in which they avoid collisions be attributed entirely to repulsions set up in the currents which by their movements they create, any such mechanical explanation certainly cannot apply to the small creatures seeking one another for the purposes of prey, reproduction, or as it sometimes seems, of mere sport. There is a common and well-known rotifer whose body is of a cup shape provided with a very active tail, which is armed at its extremity with strong forceps. I have seen a small specimen of this rotifer seize a much larger one with its forceps and attach itself by this means to the side of the cup. The large rotifer at once became very active, and swinging about with its burden until it came to a piece of weed, it took firm hold of the weed with its own forceps, and began the most extraordinary series of movements, which were obviously directed towards ridding itself of its encumbrance. It dashed from side to side in all directions with a vigour and suddenness which were highly astonishing, so that it seemed as if the animalcule would either break its forceps or wrench its tail from its body. No movements could possibly be better suited to jerk off the offending object, for the energy with which the jerks were given, now in one direction and now in another, were, as I have said, most surprising. But not less surprising was the tenacity with which the smaller rotifer retained its hold. . . . This trial of strength, which must have involved an immense expenditure of energy in proportion to the size of the animals, lasted for several minutes, till eventually the small rotifer was thrown violently away. It then returned to the conflict, but did not succeed a second time in establishing its hold. The entire scene was as like intelligent action on the part of both animals as could well be imagined, so that if we were to depend upon appearances alone, this one observation would be sufficient to induce me to attribute conscious determination to these microscopical organisms.

But without denying that conscious determination may have been present, or involving ourselves in the impossible task of proving such a negative, we may properly affirm that until an animalcule shows itself to be teachable by individual experience we have no sufficient evidence derived or derivable from any number of such apparently intelligent movements that conscious determination is present. Therefore I need not wait to quote the observations of the sundry microscopists who detail facts more or less similar to the above, with expressions of their belief that microscopical organisms display a

* 'Animal Intelligence,' 8vo, London, 1882.

certain degree of instinct or intelligence as distinguished from mechanical or wholly non-mental adjustment. But there are some observations relating to the lowest of all animals, and made by a competent person which . . . in my opinion prove that the beginnings of instinct are to be found so low down in the scale as the Rhizopoda."

The observations of Mr. H. J. Carter are then quoted.* One relates to *Æthalium*, which will make its way over the side of a watch-glass to get to the sawdust in which it has been living. In another case he saw an *Amœba* climb up the stalk of an *Acineta* which contained a young one ("tender and without poisonous tentacles"), place itself round the ovarian aperture, receive the young one, incept it, descend from the parent, and creep off with it. This Dr. Romanes considers, although certainly very suggestive of something more than mechanical response to stimulation, is not sufficiently so to justify us in ascribing to these lowest members of the zoological scale any rudiment of truly mental action. The subject, however, is here full of difficulty, and not the least so on account of the *Amœbæ* not only having no nervous system, but no observable organs of any kind, so that, although we may suppose that the adaptive movements described by Mr. Carter were non-mental, it still remains wonderful that these movements should be exhibited by such apparently unorganized creatures, seeing that as to the remoteness of the end attained, no less than the complex refinement of the stimulus to which their adaptive response was due, the movements in question rival the most elaborate of non-mental adjustments elsewhere performed by the most highly organized of nervous systems.

In Cœlenterates Dr. Romanes notices M'Crady's account of a medusa which carries its larvæ on the inner side of its bell, moving the manubrium from side to side to give suck to the larvæ on the sides, but he does not consider this is due to intelligence. The mode in which *Sarsia* seeks the light is in the nature of a reflex action, and he does not concur in Dr. Eimer's distinction between the "involuntary" and "voluntary" movements of medusæ.

Some of the natural movements of the Echinodermata, as also some under stimulation, are very suggestive of purpose, but Dr. Romanes has satisfied himself that there is no adequate evidence of the animals being able to profit by individual experience, so that there is no adequate evidence of their exhibiting truly natural phenomena.

Of Vermes, the only instances cited are Mr. Darwin's observations on earth-worms, and Sir E. Tennent's on Ceylon land-leeches.

In Mollusca, the more important observations relate to snails, limpets, and oysters. There is no doubt, he considers, that if a larger sphere of opportunity permitted, adequate observation of the Cephalopoda would prove them to be much the most intelligent members of the Sub-kingdom.

The foregoing occupies pp. 18–30 of Dr. Romanes's book; the remainder (pp. 31–498) deals with Ants, Bees and Wasps, Spiders and Scorpions, remaining Articulata and the Vertebrates.

* Ann. and Mag. Nat. Hist., xii. (1863) pp. 45–6.

Mollusca.

New Type of Mollusc.*—W. H. Dall describes a remarkable new form of mollusc, being a pelecypod or lamellibranch with an internal shell.

The animal is about 1 in. in length, somewhat of the shape of a small globose *Cyprœa*, of inflated ovoid form, translucent, jelly-like, dotted above with small, rounded papillæ, which appear of an opaque white on the general translucent ground. The mantle which covers the dome of the body is tough and thick: the sides are smooth, and nearly free from papillæ. The superior median line is a little depressed. The basal part of the anterior end in life is prolonged beyond the general mass in a wide trough, with the convexity upward, and somewhat expanded at its anterior extremity. About one-third of the way from the anterior end, the mantle is perforated by an orifice, which pierces it in the vicinity of the mouth. The edges of this orifice project from the general surface, and it is lined with close-set, small papillæ. At about the same distance from the posterior end is another tubular perforation, holding a similar relation to the anus; which has, however, plain edges, and is not internally papillose.

Turning the animal over, we find the anterior trough of the mantle prolonged backward, like a slit with plain edges, to about the posterior third; from this projects a narrow, hatchet-shaped foot, with a strongly marked byssus-gland at its posterior angle; from this a bunch of white byssus extends to the stone or other object to which the mollusc attaches itself. The cavity of the mantle extends some distance behind the commissure of the pedal opening. The anterior point of the foot is roofed by the trough-like expansion above mentioned. The mouth is provided with two pairs of small palpi. Two gills, very finely microscopically laminate, extend backward from near the mouth, on each side, to the posterior end of the body, the wider one being the inner: between their posterior ends a thin reticularly perforate veil connects the two pairs, and shuts off the anal area from the rest of the mantle cavity. The intestine contains a hyaline stylet, and is considerably convoluted; but the viscera offer no marked peculiarities when compared with ordinary pelecypods. The shells are enclosed in two little sacs in the substance of the mantle. The umbones are near together, apparently connected by a brown gristle resembling an abortive ligament, and are nearly over the heart. The valves are about 10 mm. long and 1 mm. wide, destitute of epidermis, prismatic or pearly layers. There are no muscular or pallial impressions, no adductors, hinge, or teeth. They resemble in form the exterior of *Gervillia*, as figured by Woodward, and are pure white. As they lie in the body, they diverge at a rather wide angle from the beaks, forward. The embryonic valves are retained like two tiny bubbles on the umbones.

Whatever be its relations to the higher groups, a point to be determined by further study, there can be no doubt that the animal

* Science, iv. (1884) pp. 50–1.

forms the type of a new family, Chlamydoconchæ, and the author gives it the name of *Chlamydoconcha Orcutti*. It is evident already, that the genus does nothing toward bridging the gap between the gastropods and pelecypods, but is simply a remarkably aberrant form of the latter group, and probably derived from some form with an external shell.

Taking-in of Water in relation to the Vascular System of Molluscs.*—E. Ray Lankester, while recognizing that the supposition that water is admitted by pores into the vascular system of molluscs is supported by the commonly received doctrine that water is admitted by the madreporite to mix with the cœlomic fluid of Echinoderms, and that its correlated outpouring is favoured by the undoubted fact that the cœlomic fluid is occasionally shed through the dermal pores of the earthworm, doubts its occurrence in molluscs in consequence of having ascertained the presence of hæmoglobin in the plasma of the blood-fluid of *Planorbis*, and in the corpuscles of *Solen legumen*. In *Solen* no shedding-out of blood-fluid occurs while the surface of the animal is uninjured, and the complete distension of the foot is produced by the simple mechanism of a rapid flow of blood from the mantle and body into the foot. *Planorbis* presents evidence of essentially the same kind.

A distinction must be made between the outpouring of the vascular fluid and the introduction of water through pores on the surface; on the whole there seems to be no sufficient proof that the pericardium of molluscs is in any case (except that of the Neomeniæ) a blood-space; and, therefore, the blood cannot escape through it and the renal organs to the exterior.

The view that water is introduced by pores in the foot is not supported by Lankester's observations on *Anodon* or *Solen*, and these pores must be demonstrated, by the supporters of the doctrine, in a way which will satisfy a histologist, and the evidence must not be allowed to rest on experiments made by the diffusion of a soluble colouring matter; it is to be noted that Griesbach, the present leading supporter of the doctrine, has found that finely divided coloured powder cannot be made to enter the vascular system through the surface of the foot.

Eyes and other Sense-Organs in the Shells of Chitonidæ.†—H. N. Moseley, on examining a specimen of *Schizochiton incisus* dredged in the Sulu Sea, was "astonished to remark on the shells certain minute, highly refracting, rounded bodies arranged in rows symmetrically." On further examination they were found to be eyes, and on search being made in other genera, they were detected in the majority, but in each genus they differ more or less in structure and arrangement. These eyes are entirely restricted to the outer surface of the shells on their exposed areas, and do not extend on to the laminæ of insertion; they are mostly circular in outline, and measure from 1/175 to 1/600 in. They are surrounded and set off by a narrow zone of dark pigment, and in the centre of each convex spot

* Zool. Anzeig., vii. (1884) pp. 343–6.

† Ann. and Mag. Nat. Hist., xii. (1884) pp. 141–7.

is a smaller darker area, due to the outline of the iris, but with a brilliant speck of totally reflected light, due to the lens. Numerous longitudinal canals lodge a specially large stem of soft tissue and nerves, which ramifies towards the surface and terminates either in eyes or in peculiar elongated bodies which are, apparently, organs of touch. From these latter the eyes may be supposed to have arisen by modification. The corneæ, which are calcareous, are seen in section to be formed of a series of concentric lamellæ; the pear-shaped cavity of the eye is lined by a dark brown pigmented choroid of a stiff and apparently somewhat chitinous texture. The lens is perfectly transparent and strongly biconvex. At some distance from the eye the optic nerve is a compact strand, but in the very long tube continuous with the choroid its numerous fine fibres are much separated from one another. The retina is formed on the type of that of *Helix*; and not as might be supposed, on that of the dorsal eyes of *Oncidium*; it is not perforated by the optic nerve, but it is composed of a single layer of very short, but extremely distinct and well-defined rods, with their ends directed towards the light. A number of the fibres of the nerve do not enter the retina at all, but terminate in small plugs of tissue corresponding to the minor organs of touch; they appear to form a sensitive zone round each eye. The choroid sacs have a curious open fold which calls to mind the choroid fissure. In some genera—e. g. *Chiton*—eyes are entirely absent, though the small and large touch-organs are present.

The difficult problem of the classification of the Chitonidæ will probably be rendered easier, owing to the differences in arrangement and number of the eyes in different genera; in *Corephium aculeatum* there must be 3000 on the anterior shell alone, counting only those in good condition; and on the remaining shells as many as 8500.

Prof. Moseley has been unable to trace the nerves to their source, but he doubts not that they proceed from the parietal (branchial) nerve. He concludes that the tegmentary part of the shell of the Chitonidæ is something *sui generis*, entirely unrepresented in other Mollusca. Its chief function seems "to be to act as a secure protection to a most extensive and complicated sensory apparatus, which in the Chitonidæ takes the place of the ordinary organs of vision and touch present in other Odontophora." There are some curious resemblances to the Brachiopoda.

The eyes are ordinarily hard to see on a dried shell with a powerful lens; the shell should be wetted with spirit and examined with a lens as powerful as Hartnack's No. 4 objective.

Renal Organs of Embryos of Helix.*—P. de Meuron describes the primitive renal organs of *Helix* as arising from ectodermal invaginations, and not as being mesodermal in origin as are, according to Rabl, the kidneys of the aquatic Pulmonata. The walls of the organ are formed by large cells, with enormous nuclei, which are set in a radiate fashion round the central canal of the tube; some of the cells become of a particularly large size, as in the forms studied

* Comptes Rendus, xcviii. (1884) pp. 693-5.

by the German embryologist. The internal end of the organ is very difficult of detection among the mesodermal cells by which it is surrounded; however, there appears to be an orifice which is provided with vibratile cilia, essentially similar to what has been seen by Fol in the aquatic Pulmonata, and by Jourdain in slugs.

The primitive kidney does not as in *Bithynia* (Sarasin) appear to have any relation to the velum. The permanent renal organ seems to be formed from an ectodermal invagination, and a mesodermal growth. The author suggests that the pericardiac cavity is the cavity of a somite, and that another is indicated by the primitive kidney which is the excreting organ of the anterior, as is the permanent kidney of the posterior somite.

Nervous System of Parmophorus australis.*—M. Bontan describes the nervous system of the Gasteropod *Parmophorus australis*, specimens of which were collected near Sydney, as being similar in its main features to that of *Haliotis*, as described by Lacaze-Duthiers. The line of papillæ between the foot and the first fold of the mantle, is the homologue of the festooned border of the collarette of *Haliotis*. This row of papillæ forms part of the mantle, and cannot be referred to the foot. The study of *Parmophora*, in which the nervous centres are more separated than those of *Haliotis*, leaves no doubt in this respect.

Organization of Haliotis.†—H. Wegmann considers that *Haliotis* has many points in common with the Acephala. Thus:—There is a cœcum between the stomach and the intestine. The digestive tube is ciliated throughout its greater portion. There are the same connections between the liver and the digestive tubes as in the Lamellibranchs.

A series of organs, such as the renal organ, the auricle, and the gill, are in pairs instead of being odd. Two rudimentary gills, with the two that are developed, make up the four of the Acephala. The cardiac ventricle is traversed by the rectum. Two arterial passages arise from the two extremities of the heart. The venous circulation is in its fundamental characteristics that of the Acephala, and the position of the right renal organ between the branchiæ and the system is especially important. The structure and relationships of the renal organs are essentially the same in the two cases. There is also a remarkable simplicity in the genital apparatus; a complete absence of accessory glands and copulative organs; and a singular connection with the right renal organ, as in many of the Acephala.

Absorption of the Shell in Auriculidæ.‡—Crosse and Fischer illustrate and describe the peculiar absorption of the inner parts of the upper whorls of the shell in this family, and also in the genus *Olivella*. These animals appear to have the power of dissolving entirely the internal partitions of the shell, from a point some distance inside the aperture to the very apex. The only exception in the

* Comptes Rendus, xcviii. (1884) pp. 1385–7. † Ibid., pp. 1387–9.
‡ Journ. de Conchyl., xxii. (1883) p. 3. Cf. Science, ii. (1883) pp. 663–4.

family Auriculidæ is the genus *Pedipes*, in which the partitions were found intact. The absorption is not always complete, nor are the same parts invariably missing. Complete absorption was observed in *Melampus*, *Auricula*, *Blauneria*, *Marinula*, *Tralia*, *Alexia*, *Monica*, *Plecotrema*; only partial absorption in *Cassidula* and *Scarabus*. The case of *Olivella* is more remarkable, since the allied groups *Oliva*, *Ancillaria*, &c., do not, according to the authors, present this peculiarity at all. Tryon, however, observes * that in *Oliva reticularis* he has found the walls absorbed away, so that very little of the substance remained, and considers it probable that all shells with close volutions are in the habit of absorbing them internally. It is certainly the case with many of them.

Development of the Digestive Tube of Limacina.†—S. Jourdain, having reminded us that the first indication of the pharyngeal vestibule of the Limacina appears as an invagination of the vitelline mass, and that, later, another invagination, which corresponds to the anal opening, appears in the middle line, between the two external openings of the segmental organs, now tells us that the base of the pharyngeal invagination is continuous with a cavity, the walls of which are mesodermal and are lined by endodermal cells. The digestive tube has, at this period, the form of a sac ending in a spherical diverticulum, which will become the gland that is incorrectly spoken of as the liver. This gland has at first a mesodermal and an endodermal origin; the framework being formed of mesoderm, and the secreting tissue of endoderm. The hepatic tissue is filled with a finely granular fluid, which is coagulated by heat, alcohol, or nitric acid, but does not lose its transparency; it is a kind of secondary yolk, the quantity of which increases rapidly during the early periods of embryonic development, and which fills the digestive tube. It probably arises from the elaboration of the albumen of the egg and is digested by the embryo during its development.

The internal wall of the alveoli of the hepatic sac gives rise to cells by budding; these cells gradually take on the characters of the secreting elements of the liver, so that each alveolus becomes a lobe of the hepatic organ. This organ ought not to be called a liver: it is only a diverticulum of the stomachal portion of the intestinal tract. It performs so many functions that it would be better spoken of as a chylific gland. Moreover, its mode of development may explain the bizarre forms that it sometimes attains, as for example, in the Eolidiæ, where we may suppose that each of the alveoli of the organ became isolated, acquired a great size, and took the form of the varied appendages which are found in those Gastropoda.

Molluscoida.

Simple and Compound Ascidians.‡—W. A. Herdman is unable to find a single satisfactory character by which to distinguish simple from compound Ascidians. Reproduction by gemmation and the

* Man. Conch.: Olivella, p. 64.
† Comptes Rendus, xcviii. (1884) pp. 1553–6.
‡ Nature, xxix. (1884) pp. 429–31.

formation of colonies in the latter group will not hold, since it is possible to pass from *Ciona*—a typical simple Ascidian—to *Distoma* and the very heart of the compound Ascidians through the following series of forms, which shows a perfect gradation of these characters :—*Ciona*, *Rhopalæa*, *Ecteinascidia*, *Clavelina*, *Diazona*, *Chondrostachys*, *Oxycorynia*, *Distoma*. The formation of common cloacal cavities, canals, and apertures cannot be considered as a diagnostic feature of the compound Ascidians, as there are forms considered by all authorities as Synascidiæ, such as *Chondrostachys*, *Diazona*, *Distoma*, and others, in which the atrial apertures of the Ascidiozooids open independently on the surface of the colony, and no common cloaca is formed.

The characters taken from the condition of the test, break down like the others. In the first place, in passing along the series of forms connecting *Ciona* and *Distoma*, we encounter all stages between a distinct test or tunic for each individual, and a common mass in which a number of Ascidiozooids are imbedded. And secondly, the remarkable group "Polystyelæ" presents many of the characters of highly differentiated simple Ascidians (the Cynthiidæ) along with the supposed Synascidian feature of a colony composed of many Ascidiozooids completely buried in a common test.

Digestion in Salpa.*—Dr. C. S. Dolley combats the view of Korotneff as to the existence of a large amœboid cell or plasmodium in the œsophagus or stomach of *Salpa* which carries on a form of parenchymatous digestion of the food passing the resulting chyle into the walls of the intestine by means of its pseudopodia.

Dr. Dolley has observed the appearance in the intestines of *Salpa*, which had been described by the Russian author, but he suggests an entirely different interpretation. In *Salpa* we find a large branchial sac, representing the true pharynx, at the posterior portion of which is the stomach. The endostyle, or thickened bottom of a fold or groove of the branchial sac, throws out a supply of mucus, which covers the surface like a curtain, and in which nutritive particles finding their way into the animal are imbedded. The food is carried back by cilia, and the mucous sheet is wound up into a thread, which can be traced into the œsophagus, and from there to the stomach. This mucous exudation is the amœboid cell of Korotneff.

Fresh-water Bryozoa.†—K. Kräpelin has been able to find, in the neighbourhood of Hamburg, examples of all the genera (except perhaps *Lophopus*) of Bryozoa that are known to inhabit the fresh waters of Europe. In addition to these he found large masses formed by colonies of *Pectinatella magnifica*, described by Leidy as living near Philadelphia. In this genus, in *Cristatella*, and possibly also *Lophopus*, the statoblasts are set free on the death of the colony. The author asks for the assistance of correspondents for the purpose of making a more complete investigation into the biology and geographical distribution of these animals.

* Proc. Acad. Nat. Sci. Philad., 1884, pp. 113–5.
† Zool. Anzeig., vii. (1884) pp. 319–21.

Supposed new species of Cristatella.*—E. Potts describes the discovery of aggregations of colonies of a species of *Cristatella* (*C. lacustris*) apparently differing from *C. mucedo* of Europe and *C. Idæ* and *C. ophidioidia* of America. He considers it to be at least as clearly differentiated from any of the other species as they are from each other, though probably, as the differences existing amongst them are not considerable, all should be merged under *C. mucedo*.

Arthropoda.

a. Insecta.

New Type of Elastic Tissue, observed in the Larva of Eristalis.†—H. Viallanes has directed his attention to the curious movements of the respiratory tube which is found at the end of the body in the larvæ of *Eristalis*. It is formed of a number of cylinders, which can be shortened or elongated at the will of the animal: the elongation is effected by the contractions of the body, by means of which fluid is driven into it, and its shortening by special muscles and internal elastic bands. Each of these elastic bands is formed by a single cell, which is so constructed as to act as a piece of caoutchouc. The cell is fusiform in shape, and, while one of its extremities is attached to the neighbouring integuments, the other is prolonged into a process which is fixed to the inner face of the respiratory tube. The cell and its prolongation are invested in a membrane, which is of some thickness, but is very elastic. At the centre of the cell there is a very large spherical nucleus, which is surrounded by a quantity of protoplasm, which is also found in the prolongation. Within the cell itself there is developed a long elastic fibre, similar in its physical properties to those seen, for example, in the cervical ligament of a mammal; it is folded a large number of times around the nucleus, and passes in a straight line through the prolongation of the cell, to the extremity of which it is attached; by the other it fuses with the protoplasm of the cell. When the cell is drawn out the coiled portion becomes unfolded.

The facts detailed are of interest, as proving the high degree of complexity that may be attained within the limits of a single cell, and as throwing a new light on the morphology of elastic tissue, since they show that this may be, as in vertebrates, developed in the intercellular substance, or, as in *Eristalis*, in the protoplasm itself. It may be noted that striated muscular tissue presents analogous variations.

It would seem, then, that the same tendency obtains in elastic as in muscular tissue; in both cases, perfection is attained by parts leaving the protoplasm of the cells to which they primitively belonged, and, by becoming intercellular, being converted into the undivided property of neighbouring cells.

Submaxillary of the Jaw of Mandibulate Insects.‡—J. Chatin retains the name of submaxillary for the part of the buccal apparatus

* Proc. Acad. Nat. Sci. Philad., 1884, pp. 193-9 (1 pl.).
† Comptes Rendus, xcviii. (1884) pp. 1552-3.
‡ Ibid., xcix. (1884) pp. 51-3.

so named by Brullé, and called the cardo by Kirby and Spence. *Oligotoma Saundersii* is taken as the starting point, and its submaxillary described as being a small transverse piece slightly grooved on its inner surface. *Œdipoda cinerascens* has the same part provided with several deep articular cavities. In *Decticus* the organ is still more modified. In *Gryllus domesticus* it is strongly, and in *Phasma japetus* feebly articulated. In *Mantis religiosa* it is developed in a vertical direction, and has the appearance of some maxillæ. In *Hydrophilus piceus* the different portions of the organ are profoundly modified. The author considers that the descriptions which he gives are sufficient to show the interest which attaches to the morphological study of the submaxillary, and the changes undergone by a part which has been too often misunderstood, but whose correct interpretation is necessary in a comparative study of the appendages of the Arthropoda.

Structure and Function of Legs of Insects.*—F. Dahl ascribes our ignorance of the structure and functions of insects' legs to the fact that on the one hand most entomological works are of a purely systematic character, and that, on the other, anatomists have chiefly busied themselves with the axial parts only; in fact, Strauss-Durckheim, Newport, Burmeister, and Graber are the only authors to whom Dahl makes reference in his introduction.

The constancy of the number of six is probably to be explained as being in relation to the function of the legs as climbing organs; one leg will almost always be perpendicular to the plane when the animal is moving up a vertical surface; and on the other hand we know that three is the smallest number with which stable equilibrium is possible; an insect must therefore have twice this number, and the great numerical superiority of the class may be associated with this mechanical advantage. This theory is not weakened but rather supported by the fact that the anterior pair of legs is rudimentary in many butterflies, for these are almost exclusively flying animals.

The author describes in some detail the arrangements of the muscles of the legs; the nerve-cord supplying them is pretty stout, and the large number of filaments sent to the joints of the tarsus lead to the supposition that these have a tactile function; the nerve-fibres are seen to enlarge into thick spindle-shaped ganglia. There are two tracheal trunks.

The prime function of the legs is locomotor, and insects move through gaseous, fluid, and solid media. The last is seen in fossorial forms, of which *Gryllotalpa* may be taken as the type; here some of the joints are flattened out and provided with teeth, and the muscles are well developed. In some cases legs of a fossorial type are possessed by insects which move on the ground, but the larvæ of which are subterranean in habitat. The water-beetles and aquatic Rhynchota have the legs converted into swimming organs; they are widened out into plates and provided at the sides with movable hairs, which are directed slightly backwards. The median pair of legs in *Corisa* is provided with two very long hooks, the function of which is

* Archiv f. Naturg., l. (1884) pp. 146–93 (2 pls.).

to fix the animal at some depth among the water-plants, and so to prevent its floating upwards.

In the aerial forms we have first to notice those that move on the surface of the water; in these the legs are often provided with considerable enlargements of the tracheal trunk, by means of which they are enabled to float. Others have very long legs by which they can balance themselves and extend over a large surface of the water; the lower surface of the tarsal joints, or that which is in contact with the water, is provided with thick hairs. In some Diptera hairy lobes are developed. Arrangements for climbing are very widely distributed, and are very various in character; the most common are hooks which by their sharp tips are able to enter the smallest depressions and so obtain a firm hold; sometimes they are cleft and are thus adapted to hold on to fine branches; sometimes they are pectinate and enabled to catch hold of fine hairs.

In very many cases there are organs of fixation; in the locust they have their chief mass made up of a large number of free flexible rods (not tubes). The periphery is occupied by scales which correspond in number to the rods, with which they appear to be connected by fibres; the space between the rods is filled with a fluid. Below these are groups of spindle-shaped cells which appear to be glandular in character. The fixing surface of the Hymenoptera, Neuroptera, and Lepidoptera consists of an unpaired lobule placed between the hooks; their structure is most complicated in the first-named order. Observations on *Vespa crabro* did not result in the detection of any space which could be regarded as a vacuum. The lower surface of the lobule is soft and almost smooth; a few short hairs may be developed at its base; below this is a hard chitinous mass with stronger hairs. The upper surface is either covered with hairs or is finely folded. Near the base is a chitinous plate carrying a pair of strong setæ. Within is an elastic bar which is rolled up in a condition of repose; when extended it brings the lobule into contact with the surface on which the insect is standing. There are no well-developed gland-cells. After descriptions of other modes of fixation the author gives the following table.

A. Organs of attachment at the end of the foot.

a. Without fixing hairs	Orthoptera.
β. With fixing hairs	*Forficula.* Coleoptera. *Sialis.*

B. Organs of attachment between the hooks.

a. A distinct median lobe.	
a. The median lobe with chitinous arches.	
1. Secondary in addition to the median lobe	Neuroptera.
2. No secondary lobes	Hymenoptera.
b. No chitinous arches	Lepidoptera. *Tipula.*
β. No distinct median lobe.	
a. The lobes hairy	Diptera.
b. The lobes not hairy	Rhynchota.

The legs may, further, have a sexual function as attaching or holding organs; or, as in *Mantis religiosa*, *Nepa cinerea*, &c., they may be of use in seizing prey; and, finally, they may be used as cleansing organs. The legs in ants may be seen to be pectinate, an admirable arrangement for forms that live in dust and earth; they are often specially adapted for cleansing the proboscis, and for other functions for an account of which we must refer to the paper itself.

Organs of Attachment on the Tarsal Joints of Insects.*—G. Simmermacher first takes up the case of sexual organs of attachment in the Coleoptera, where the males have some of the tarsal joints more or less remarkable on account of their widened form, and for the possession on the lower surface of suckers which are visible to the naked eye. The differences between males and females are best seen in the Dyticidæ, where the first three tarsal joints of the first pair of limbs are distinguished from those that succeed them, on account of their greater breadth; those of the second pair are a little less remarkable. The suckers that are developed belong to the group of modifications which were associated together by Plateau under the head of "cupules sessiles," but the author finds that the large suckers have a stalk, and they are, further, distinguishable from the smaller suckers by the presence of better developed and more numerous ridges. The stalk is traversed by a canal. The disposition of the suckers on the joints is described.

The tarsi are moved by a strong muscle, the long axis of which is parallel to that of the foot; it is attached to the chitinous exoskeleton at every joint, and consists of several muscular fibrils, through which pass branches of the tracheal system; the muscle is attached to the stalk of the sucker, the movement of which is, therefore, under the control of the will. The suckers are to be found on the tarsi of the males of all the twelve genera of Dyticidæ living in Germany; the differences seen are found to be constant in genera and species; such differences as obtain are due to (α) either the tarsal joints of the first and second pair of feet are partly widened out and beset with suckers (*Dyticus*), or there are suckers on the first pair only (*Cybister*); (β) the three tarsal joints on the first pair are very greatly widened and rounded, and those of the second are but little altered (*Dyticus*), or, as in *Hybius*, the first pair of feet are but little altered; (γ) the suckers are either rounded (*Dyticus*), or elongated as in *Cybister*; (δ) the suckers on one and the same joint are either all similar, or they differ in form or size, or in the form of their joints. A systematic description of the organs is given for the different genera.

Simmermacher is of opinion that the grooves on the wing-covers of the female Dyticidæ have no function in copulation, and in this he agrees with the results lately obtained by Dr. Sharp, whose important monograph he did not see till the first part of his own work had been concluded.

The Carabidæ and Cicindelidæ are next dealt with in the same manner.

* Zeitschr. f. Wiss. Zool., xl. (1884) pp. 481–556 (3 pls.).

In the second part of the essay climbing organs are dealt with; in the Chrysomelidæ, Hylobiidæ, Telephoridæ, and Cerambycidæ, the tarsi, in both sexes, are provided on their lower surface with chitinous structures which to the naked eye have the same appearance as those which are found in the males only of the families already discussed. The groups just mentioned live either in water or on leaves or stems, where they move about by means of the tubules covering their tarsi, and by the aid of which they can fix themselves in various positions. These chitinous structures are always tubular, and they are never found on more than the first three joints of the tarsi. In the tetramerous forms they are widened out and have a distinct orifice, but in the pentamerous Telephoridæ they end in a sharp point. In most cases the tubules pour out a secretion, and it is probable that we have here to do with the phenomena not of actual attachment by, as it were, glueing, but of adhesion; the orifice of the tubes is directed obliquely, and the tubes are, at this point, extremely delicate and flexible, so as to adhere by their lower surface; in this adhesion they are aided by the secreted fluid.

In the Cerambycidæ there is no secretion, and the tubules are merely sucking organs, analogous to those which are found in the male Silphidæ.

Discussing the Diptera, observations on which have been made by a number of naturalists whose results are here compared, the author describes the ordinary arrangement (such as is seen, for example, in the common house-fly) as consisting of two attaching lobes; between these there is a rod-shaped elongated piece, beset with chitinous hairs. He does not accept the theory by which the movement of the fly along smooth surfaces is ascribed to an alternate fixation and separation, but believes in a process of adhesion, aided by a secretion, just as in the case of the Coleoptera. The attaching lobes closely beset with chitinous hairs are enabled, in consequence of the pressure of the foot, to completely lie along any smooth surface; this expels the air beneath the lobes, which are then acted on by the pressure of the outer air.

There are a few observations on the Hemiptera, Neuroptera, Lepidoptera, Hymenoptera, Orthoptera, and Strepsiptera; and, in conclusion, analogous cases are cited from other divisions of the animal kingdom; sucking tubes are seen in the Acinetæ, ambulacral feet in Echinids and Asterids, sucking organs of attachment in *Chiton* and *Patella*, suckers in the Cestoda and the Hirudinea; Schmidt regards the pectines of the scorpion as having a similar function, and numerous examples are to be found among Vertebrates.

Locomotion of Insects on Smooth Surfaces.*—Dr. J. E. Rombouts writes as follows:—

"I have concluded from my experiments that it is not the pressure of the air nor the power of an adhesive liquid that gives flies the faculty of running over smooth bodies, but that the power should be

* Amer. Mon. Micr. Journ., v. (1884) pp. 99-100. From Pop. Sci. Mon., May 1884.

attributed to the molecular action between solid and liquid bodies; or, in other words, to capillary adhesion.

If we examine the under part of the pulvilli with a Microscope, we shall see distinctly that it is furnished with numerous hairs, regularly distributed. These hairs terminate, at their lower end, in a kind of bulb, the form of which varies, whence flows an oily liquid that dries slowly and does not harden for a long time. The minute drops left on the glass by the hairs may be taken away, even after two or three days have passed, without our having to moisten them, by simply rubbing a piece of fine paper over them.

I have devised an apparatus for collecting these drops by cutting a hole in a piece of board, over which I fix a glass slide. Turning the board over so that the glass shall be at the bottom, I have a little cell with a glass floor. With the aid of a piece of paper gummed to the wings, I introduce a fly into this cavity in such a manner that the pulvilli shall rest upon the floor. Then, putting the board under the Microscope with the glass slide uppermost, we have the fly's feet under our eyes. The insect, struggling for liberty, places his pulvilli against the glass, and leaves after each effort traces that may be observed very distinctly, for they are perfectly visible in a good light.

We may discover, whenever the feet of the fly come again in contact with these tracks or minute drops, that they are composed of a very liquid substance, for they spread quite readily on the glass. We cannot admit, as some naturalists assume, that the liquid can hold the club-shaped hair-ends by suction. If this were the case, the ends would change shape during the suction, and would take the form of a disk. The fly puts its feet down and lifts them up with an incomparable facility that would not exist if the limb were really acted upon by the pressure of the air."

Organs of Flight in the Hymenoptera.*—Dr. Amans has a further paper on flying organs in insects, and in the groups now studied he recognizes as constant factors the following. The general form of the machine must be a more or less elongated oval, with its widest end directed forwards. The framework must have a solid floor with more or less elastic walls, more or less united behind so as to form a fixed transverse pivot-line; the walls must be sustained by a vertical column, and there must be a roof movable on these walls around the pivot-line, from before backwards and below upwards. The rotation is effected by means of the wings.

The "schematic form of the wing" is that of an elastic triangular surface, the breadth of which gradually diminishes from before backwards, and from base to summit, the latter being centrifugal. For its articulation the wing must have a double articular surface at its point of attachment, and the movable roof must articulate with the apex of the angle of the dihedron. The surface in front of the point of attachment must be one of pronation, that behind it of supination. The motors are (*a*) forces that are elevating, retracting, and divari-

* Rev. Sci. Nat., xii. (1884) pp. 482–522 (2 pls.).

cating; (*b*) forces antagonistic to the preceding; (*c*) propulsive, flexing and depressing the anterior plane; and (*d*) forces which depress and propel the posterior plane. The first two of these are inserted into the roof and floor, the last two into the base of the wing. The motor forces are the voluntary muscles, the actions of which are combined with involuntary, that is, elastic forces: of the latter, the chief are the resistance of the roof to the curvature caused by the former when the wing is depressed, and the resistance of the anterior part of the point of support to the flexion due to the muscles of group (*c*).

The author bases these conclusions on what he has seen in the Orthoptera, Pseudo-neuroptera, and Hymenoptera.

Poison of the Hymenoptera and its Secreting Organs.*—G. Carlet, in opposition to previous observers, finds that the venom-producing apparatus of the Hymenoptera is always formed by two distinct systems of glands, one of which has a secretion which is strongly acid, and the other feebly alkaline. The two systems open at the base of the spine, and the combined liquid is always acid. Experiments made on the common house-fly showed that the sting of a venomous Hymenopteron was always followed by the immediate death of the fly, but that the inoculation of the product of either of the glands does not result in death, or only in death after a long interval. The successive inoculation of the two secretions leads to death shortly after the second inoculation, and we may suppose that life ceases as soon as the two liquids have mixed. It is then clear that the union of the acid and alkaline secretions is necessary for the venom to have any fatal effects.

Development of Cerocoma Schreberi and Stenoria apicalis.†—H. Beauregard communicates some facts as to the development of certain insects allied to *Cantharis;* the larvæ appear to be mellivorous, and it is possible that they may live as parasites indifferently in certain Hymenoptera. The larvæ, contrary to the habits of *Epicanta* and *Macrobasis*, as described by Riley, do not live on the eggs of Orthoptera. It has been found that the larva of *Cerocoma* lives on the honey of *Colletes* and of *Osmia*.

Other pseudochrysalids found in the cells of *Colletes signata*, and presenting a very regular ovoid form, of a golden yellow colour, and enveloped in a very fine iridescent pellicle, were watched through the winter, and found in May to commence to undergo a series of metamorphoses which ended in the appearance of the adult *Stenoria apicalis*, which was found by Lichtenstein to be, in its earliest stages, parasitic on *Colletes fodiens*. Here, again, therefore, we have evidence as to the indifference which these parasites exhibit as to their choice of a host. The history of development justifies the separation of *Stenoria* from the true *Sitaris*.

Dipterous Larvæ.‡—Dr. F. Brauer has published a valuable monograph on this subject, the result of ten years' labour.

* Comptes Rendus, xcviii. (1884) pp. 1550–1.

† Ibid., xcix. (1884) pp. 148–51.

‡ Denkschr. K. Akad. Wiss. Wien, xlvii. (1883) 100 pp. (5 pls.). Cf. Amer. Natural., xviii. (1884) pp. 609–11.

After lengthy remarks on the systematic relations of different groups of Diptera, based on the larval characters, he states that the typical, inherited feature in the entire group of Dipterous larvæ appears to be the position of the brain, whether it is contained in a head-capsule, or free, i. e. far behind the mouth or immediately behind the chitinous capsule, supporting some of the mouth-parts, and containing the œsophagus. Less important characteristics are then enumerated. A very unsafe character is the number of visible body-segments.

The characters of the dipterous larvæ in general are laid down and the value of the larval characters in classification discussed. A tabular view of the nervous systems of the larval as compared with the adult Diptera is followed by a section on the character of the sub-orders and families which occupies the greater part of the work. It is succeeded by short descriptions of a few larvæ of the families Tabanidæ, Leptidæ, Dolichopidæ, and Empidæ.

Larvæ of North American Lepidoptera.*—A. Gruber gives a description of the larvæ of some Papilionidæ and Nymphalidæ; scanty as his material seems to have been, he thinks that the larvæ before him give indications of the possibility of making out the genetic relations of the species.

The first stage of the larvæ of the Papilionidæ is distinguished by the constant possession of well-developed warts, on which there are long setæ that give a hairy appearance to the caterpillar. They are longest on the most anterior and the most posterior rings of the body and a correlation is apparent between the thoracic and the three last abdominal segments. After each ecdysis the warts decrease in size, and sooner or later disappear altogether; the smallest, or those on the median segments, are the first to be lost. The function of these warts appears to be that of providing suitable and prominent points of attachment for the setæ; it is to be noted that the warts are rudimentary in proportion to the distinctness of the markings on the caterpillar. It is these markings that have been seized upon by natural selection, and the other characters, which have lost their significance, have been gradually suppressed. When the warts do not interfere with the markings, as in the case of larvæ with black transverse bands, they do not completely disappear until the last ecdysis.

We may, therefore, suppose that the larvæ of the Papilionidæ have been derived from forms which were indifferently coloured and not strongly marked, and which possessed strong setigerous warts; all the larvæ in their first and even in their second stage, resemble this hypothetical primitive form. Numerous intermediate conditions are to be observed between it and the conspicuously marked forms found at the present time, and each larva more or less completely repeats, at its ecdyses, the phylogenetic history of its species.

Further than this, we may suppose that those larvæ which retain their warts longest are the oldest forms, or those that stand nearest to the primitive form.

The Nymphalidæ present arrangements which are the opposite

* Jenaisch. Zeitschr. f. Naturwiss., xvii. (1884) pp. 465–87 (2 pls.).

of what are seen in the Papilionidæ, for, in the first stage, the setæ are set on inconspicuous elevations of the integument; in the second there are conical warts, and these increase in size with each ecdysis: the warts of the Nymphalidæ are, therefore, not inherited, but acquired structures; their armature becomes of great importance and affects their external form.

The most primitive setæ appear to be those which are long, slightly curved, and finely toothed on their margin; in the course of development they become simply smooth or swollen at their base.

The author hopes that the suggestions he puts forth will be examined by those who have access to a larger number of examples, and justly remarks that the investigation would be very valuable and interesting.

Drinking Habit of a Moth.*—E. D. Jones describes a remarkable drinking habit of a yellow and black Brazilian moth (*Panthra pardalaria*). He found these moths sitting on the wet stones in small streams near San Paulo, sucking up the water in a continuous stream, and letting it escape in drops from the abdomen. These drops fell at the average rate of 50 per minute, and as near as he could judge of their size, the total quantity of water which must thus pass through the body of the moth in three hours must be a cubic inch, or about 200 times the bulk of its own body. Mr. Jones speculates on the possible meaning of this and asks—"Can it be that the moth extracts nourishment from minute particles of organic matter contained in the water?" He remarks, however, that the water of the streams appears very clear and pure, and notes that the moths seem specially adapted for this habit. The tibiæ of the hind legs are very thick, and are armed with long hairs, which by their capillary action prevent the moth being immersed in the water "I have often," he adds, "seen one of them knocked down by a little spurt of water splashing over the stone on which it was standing, and it recovered itself almost immediately without being wetted in the least."

γ. Arachnida.

Michael's British Oribatidæ.†—It would be difficult to say too much in praise of this book which the Ray Society are fortunate in being able to publish as one of their invaluable series, while this Society may congratulate itself in numbering among its active members an author who has produced a work which has required so much labour and skill and so much perseverance, and which will rank as one of the not too numerous standard works in the English language devoted to sections of the Invertebrata. The author's tribute to the assistance rendered him by his wife, is an additional justification (if any is required) for the resolution which he recently moved for the admission of lady Fellows to the Society.

The classification of the Oribatidæ is fully dealt with, followed

* Proc. Lit. and Phil. Soc. Liverpool, xxxvii. (1883) pp. lxxvi.–vii.

† Michael, A. D., 'British Oribatidæ,' xi. and 336 pp. (3 pls.) 8vo. Ray Society, 1884.

by a chapter on their development and immature stages, the observations necessary for which were the most laborious part of the author's undertaking, involving the rearing of a large number of the microscopic animals in confinement, and their careful watching and the regulation of their hygrometic conditions every day for months! They had indeed to be carried about with him on any journeys. Amongst the habits of the Oribatidæ are enumerated their avoidance of light, which increases so much the difficulties of observation, their habit of carrying a portion of their cast skins and piling up dirt and rubbish on their backs to form an artificial covering, or investing themselves with a white substance. From the chapter which gives very detailed directions on collecting and preserving, we have already made some extracts.*

The remainder of the book deals with the anatomy of the exoskeleton and internal anatomy (pp. 110–190) and with the description of genera and species (pp. 191–327). 31 plates, mostly coloured (some of which have appeared in this Journal in connection with Mr. Michael's various papers), illustrate the text.

A type series of slides has been deposited by Mr. Michael in the Society's cabinet.†

δ. Crustacea.

Stomach of Podophthalmate Crustacea.‡—In this important contribution to our knowledge of the anatomy of the higher Crustacea, F. Mocquard, after the ordinary historical review, points out that in the Decapoda there are important differential characters, distinguishing the Brachyura from the Macrura, but that, as is already known, the so-called Anomura belong, some to the brachyurous and some to the macrurous type. When we review all the families we find in every natural one that the gastric apparatus is arranged on a special and characteristic type.

In the Brachyura the mesocardiac piece is narrow and triangular, while the pterocardiac ossicles are elongated and directed horizontally; in the Macrura, on the other hand, the former occupies the whole of the transverse line of the superior cardiac wall, while the latter are ordinarily shorter than in Brachyura and are set almost vertically. Although it is true that the short-tailed forms never present the characters seen in the gastric ossicles of the long-tailed, the converse proposition does not hold good, for in such Macrura as have undergone some degeneration, the ossicles are formed on almost the same type as in the Brachyura. The more detailed account of the differences between these two groups are set forth in the paper.

In passing from the normal Brachyura to the abnormal (or apterurous Anomura), we observe a certain number of characters intermediate between what are seen in the Brachyura on the one hand, and the Macrura on the other; and it is to be noted that, on a consideration of nothing but the arrangements of the parts of the gastric skeleton, we should ascribe to them that intermediate position which

* See this Journal, *ante*, p. 635. † Ibid., p. 500.
‡ Ann. Sci. Nat. (Zool.), xvi. (1884) 311 pp. (11 pls.).

is commonly ascribed to them, after a study of their characters in general.

Notwithstanding the numerous differences presented by different groups, in the successive series of degradations which are to be detected, it is possible to show that the gastric skeleton is never modified except by change in the form or relations of its parts, by their coalescence and disappearance; nothing new is ever added, and even when most degraded, the homology of the different parts can be asserted almost with certainty. In other words, the gastric skeleton of all the podophthalmate Crustacea is constructed on the same plan.

The author makes some remarks from a systematic point of view, and urges that the importance of the characters of the stomach is to be explained by the fact that it is not directly subjected to external influences, and is much less exposed to the changes which result from adaptations to environment than are the external organs. These characters then, are of great value in determining the relationships of genera with a different external appearance.

Mocquard describes the arrangement of the muscles which move the various ossicles, and facilitates the comprehension of his description by his figures; he finds that, at the moment when the gastric muscles contract the median tooth moves forwards, and the anterior ends of the lateral teeth approach one another; when the gastric muscles relax the apparatus is brought back to its position of equilibrium, by the elasticity of its articulations, and by the action of the cardio-pyloric muscle. When the gastric apparatus is acting, the food tends to be driven upwards, but its passage is prevented by the projections on the urocardiac ossicle. The medio-inferior tooth, though with the form, has not the function of a tooth; its conformation has no relation to that of the median tooth, and one of the two may vary in form, without the other doing so likewise.

The author agrees with Cuvier in thinking that the gastric muscles are voluntary in nature.

The concluding chapter deals with the stomatogastric nervous system, the knowledge of the distribution of which is thought to throw a new light on its physiological activity. While some authors, such as Meckel and J. Müller, have compared it to the great sympathetic of vertebrates, others, such as Newport and Blanchard, have compared it to the pneumogastric nerve. The latter view can only be justified by showing that the stomatogastric system presides over the functions of general sensibility and involuntary movement; as a matter of fact, however, in the Crustacea, the fibres that pass to the muscles of the œsophagus and labrum are clearly voluntary, and the same is almost certainly true of the branches that go to the motor muscles of the gastric apparatus, and possibly also of those that supply the dilatators and constrictors of the stomach; some of those that go to the labrum seem, moreover, to have a gustatory function. It is possible, however, that the different roots of the stomatogastric have different functions, and that, when united, they form a mixed trunk more complex even than that of the vagus after its union with the internal branch of the spinal. No observations on this point have as yet been made.

Significance of the Larval Skin in Decapods.*—H. W. Conn discusses the phylogenetic significance of the peculiar structure inclosing embryos of Crustacea known as the larval skin. This skin being probably of no physiological importance, is therefore particularly valuable in its morphological significance.

A number of new types of larval skin are described (*Callinectes*, *Sesarma*, *Pinnotheres*), and it is shown that there is a complete and graduated series beginning with a form like *Panopeus*, where the larval skin is a highly complex structure with many feathered spines, and ending in a form like *Pinnotheres*, where the cuticle is nothing more than a larval covering with no spines. In general also it is found that the more complex larval skin is found in crabs, which stand low in classification, while the simple larval covering is found in more highly organized Brachyura; a condition of things just as we should expect from the consideration that this structure represents the ecdysis of some stage in the crab development earlier than the zoea. It is further shown that such an earlier stage was probably a protozoea and that we, therefore, have here strong evidence that this stage was formerly included in the ontogeny, and therefore in the phylogeny of the Brachyura. Finally it is argued that evidence is here obtained tending very strongly to show that the Decapod zoea is simply a larval form which has never been represented in the phylogenetic history of the group, contrary to what has been claimed by Müller, and later in a different form by Balfour.

New or Rare Crustacea.†—In his 34th article on this subject M. Hesse describes five new Crustacea belonging to the order which he has called that of the Rostrostomata; like the Siphonostomata, they are found on the skins of the Squalidæ, but, unlike them, they have not a rigid tubuliform mouth by means of which they can penetrate the thick skin; the mouth is rather obtuse and soft, and the animals, therefore, make their way into the branchial cavity, where they are sheltered and early obtain a rich supply of food.

The new species, of which the females are alone known, are called *Kroyeria galei vulgaris*, *Eudactylina squatinæ angeli*, *Eudactylus musteli lævis*, *E. charchariæ glauci*, and *Pagodina charchariæ glauci*. The author concludes with some observations on the systematic position of these species.

Vermes.

New Type of Hirudinea.‡—MM. Poirier and A. T. de Rochebrune describe a new type of Hirudinea which they found attached not only to the mucous membrane of the mouth of *Crocodilus vulgaris*, *Cataphractus*, and *Leptorhynchus*, but also on the lingual papillæ of *Cymnoplax ægyptiacus*, and in the pouch of *Pelicanus* and *Onochrotalus*. In external appearance it has a general resemblance to *Branchiobdella*. Attached to the very delicate rectum are four pairs of very sinuous

* Stud. Biol. Lab. Johns-Hopkins Univ., iii. (1884) pp. 1–27 (2 pls.). Cf. this Journal, *ante*, p. 226.

† Ann. Sci. Nat. (Zool.), xvi. (1884) 18 pp. (3 pls.).

‡ Comptes Rendus, xcviii. (1884) pp. 1597–1600.

tubes, which are set between the dorsal surface of the animal and the cæca. The appendages of the digestive tube are continued into the branchiæ, and the tract is also remarkable for the possession of large unicellular glands with finely granular contents; these form the salivary glands.

The male generative apparatus is composed of four pairs of ovoid testicles, which are placed in the last four branchiate segments; the efferent ducts unite, on leaving the epididymis, into a short azygos spermatic canal, which passes into a large muscular pouch, into which the very large penis can be retracted. The female organs consist of a pair of very long pyriform ovaries, and of two delicate oviducts which pass into an inconspicuous uterus. The circulatory system presents some remarkable characters. There is no dorsal vessel, but there are two pairs of lateral vessels, which are superposed and send branches into the branchial outgrowths; the superior lateral vessels, which may be considered as being arterial, communicate with one another in each ring by an annular vessel which sends fine ramifications to the surface of the skin; posteriorly, these two lateral canals bifurcate and unite by the branches thus formed; they here give off a number of ramifications which extend over the lower surface of the sucker, and pass into a double circular vessel which extends round the edge of the sucker. There is a median ventral vessel which envelopes the nervous system and gives rise anteriorly to a ring which communicates with the lateral vessels, and posteriorly to a number of branches which open into the vessels of the sucker. The nervous system has a close resemblance to that of *Clepsine;* there are two very large, cup-shaped orange-coloured eyes. The integument, especially in the anterior region, is very rich in glandular cells.

The new genus to be instituted is called *Lophobdella,* and the species *L. quatrefagesi;* it is found in Senegambia and the rivers of Africa. Its peculiarities require the formation of a new family, to be called the Lophobdellidæ, and placed near the Rhynchobdellidæ.

Structure of the Branchiæ of Serpulaceæ.*—Dr. L. Orley gives a detailed account of the histology of the gills in the Serpulaceæ. His results may be stated as follows:—

In *Serpula* the gill-threads are borne upon two curved lamellar processes, one on either side of the head; these are united by a cross piece; one or two of the gill-threads are modified into a stalked opercular plate; this latter in some species serves as a chamber for the development of the ova, and is generally regarded as serving to close the tube of the animal when it is retracted. Its structure, however, points to the conclusion that it may also serve as a respiratory organ (the other gill-filaments with which it is homologous being chiefly tactile). It receives a vast number of capillaries which branch repeatedly towards the distal end of the "cup," and end in ampulla-like dilatations; the advantage of such a structure to the animal must be great, since it is enabled to protect itself by closing the operculum, and at the same time the process of respiration

* MT. Zool. Stat. Neapel, v. (1884) pp. 197-228 (2 pls.).

can go on; the operculum may perhaps have been formed by the concrescence of a series of gill-branches arranged in a circle round the tip of the gill-filament.

In *Sabella* the gill-filaments differ from those of *Serpula* by the presence of a cartilaginous rod and a portion of the longitudinal muscle-layer of the body which is prolonged into them in close connection with this skeletal rod.

The paper concludes with a discussion concerning the homologies of the gills in Serpulaceæ with the gills of Vertebrata, which is believed to exist by some; the author, however, does not consider that there is any homology or even analogy between the two structures.

Structure and Development of Fresh-water Dendrocœla.*—The studies of J. Jijima are based chiefly on *Dendrocœlum lacteum*, *Planaria polychroa*, and *Polycelis tenuis* (n. sp.). Commencing with a description of the cilia, he states that, in adult forms, these are not developed over the whole surface of the body, but are absent from certain regions; they are particularly well developed at two points at the anterior margin of the head, where they form a tuft of long and constantly moving hairs; their function would appear to be sensory. Some shorter immobile cilia are found on the median portion of the cephalic margin, and among these there are some which are twice as long, and either stand separately or arise from a common base; they may be regarded as comparable to setæ. The absence of cilia from the sides of the body may be ascribed to the influence of parasitic Protozoa. It would seem that the cilia on the back of the *Geoplana* and other terrestrial Triclades, are more delicate than those on the ventral surface, and are, therefore, more easily destroyed in the process of preservation.

The author was, like Kennel, unable to detect the unicellular epidermal glands seen by Moseley, and is led to doubt their presence; a certain relation was observed between the rhabdites and the characters of the cells of the epidermis; the smaller size or number of the former being associated with a greater wealth of finely glanular protoplasm in the latter. Jijima finds that there is a very remarkable relation between the cells and the basal membrane on which they are placed; for the former give off a number of fine processes; these are best studied in *Planaria polychroa*, where they appear to be formed by fibrils, which are nothing else than direct protoplasmic processes of the cells of the epidermis; there is little doubt that there is an organic connection between the epithelium and the interior of the body.

The rhabdites, which are described in some detail, do not seem to be imbedded in the epithelium, but in the peripheral cells of the mesenchym. Each cell gives rise to several rhabdites, which are at first small and round, but which soon elongate. When they have reached their definite size they break through the cell-wall, which appears at last to be absorbed, and wander through the connective

* Zeitschr. f. Wiss. Zool., xl. (1884) pp. 359–464 (4 pls.).

tissue and the basal membrane, either separately or by groups, into the epidermal cells, where they take up their definite position. There appear to be a larger number of rhabdites in more sensitive than in less sensitive parts of the body. The basal membrane is more or less well developed in all Turbellarians. The characters of the musculature are discussed in detail, and the differences between the three species examined are pointed out.

The mesenchym contains imbedded in itself unicellular glands, which are most numerously developed behind the brain, and above and below the enteric canal. Their function is either mucous or salivary; but it is by no means certain that the latter are comparable to the similarly named glands of higher animals. In young embryos the space between the epidermis and the enteric epithelium is occupied by a solid mass of connective-tissue cells, which are partly massed into syncytia, and are partly separated by cell-boundaries. In the adult the arrangement is very different, owing to the appearance of a larger number of pseudo-cœlomic spaces, which communicate with one another, and force the nuclei away from one another, and so give rise to branching cells of connective tissue and a general appearance of reticulation. In the living animal the lacunar spaces are probably filled with the so-called perivisceral fluid, which possibly serves as a carrier for the nutriment prepared within the enteric cells. *Dendrocœlum lacteum* has, as its name implies, none of its connective tissue pigmented, as is the case in a number of other forms.

The author confirms in many points the descriptions given by his predecessors as to the characters of the digestive organs; in *D. lacteum* he finds that there are 26–34, in *Pl. polychroa* 22–28, and in *Pol. tenuis* 15–19 pairs of lateral branches to the intestine, of which 10–15, 9–13, and 4–6 respectively belong to the primary trunk of the gut. All but those at either end branch dichotomously. His account of his own observations on the excretory organs is prefaced by a statement of what has been done by recent observers; the point to which he himself directs express attention is the undoubted fact of the presence of cilia in the lumen of certain capillaries; in the median part of the body they are best developed, and take a coiled course; their movement is definite in direction, and these ciliated vessels have nothing to do with the ciliated infundibula. Many of these vessels are so fine that, were it not for their cilia, they would be invisible. The ciliated infundibula are not numerous in, at any rate, young specimens, and are often widely separated from one another. The presence of excretory vacuoles was recognized, and they were seen to be, like the vacuoles of the Protozoa, clear during life; they give some indications of containing products of uric excretion.

After a very detailed description of the generative organs, the nervous system is taken up. This was studied by the light of Lang's investigations, the general results of which are fully confirmed. Jijima had no difficulty in convincing himself of the existence of a plexus of fine nerves on the dorsal surface, lying just beneath the inner longitudinal fibres of the dermal musculature. As in other

Platyhelminths, there are two longitudinal nerve-trunks which unite posteriorly, after gradually increasing in size. The transverse commissures go directly from one trunk to the other, and often branch and anastomose with their neighbours. Both the commissures and the lateral nerves give off a number of fine branches ventrally. The brain of *Planaria polychroa* stands at a lower level than that of *D. lacteum* or *Pol. tenuis*, owing to the want of concentration of the sensory nerves into anterior cerebral lobes. The eye of *P. polychroa* is described as consisting of a pigment-goblet, an optic cone, and an optic ganglion. The first is formed of compact pigment-granules, and has its orifice directed outwards and upwards. Anteriorly to this opening there is a collection of nervous substance, surrounded by a number of nuclei, which appear to belong to ganglionic cells.

The author was unable to observe the impregnation of the ovum, and thinks it likely that the spermatozoa are to be found in the albuminous fluid of the cocoon. Directive corpuscles were not detected, probably because the ova have no investing membrane, so that their presence was obscured by the contents of the cocoon. The layer of fused cells, which early becomes developed, seems to be due to the metamorphosis of the peripheral cleavage-spheres. The embryonic pharynx is formed by the elongation of some of the endodermal cells, which become converted into muscular cells, and surround a central group of cells, which soon afterwards begins to make its way to the surface; clefts appear in this mass and lead to the gradual appearance of a lumen. This pharynx is only provisional, and is at about the twentieth day replaced by the one which is possessed by the adult. The author has, unfortunately, no observations to record on the mode of development of the excretory organs, or of the finer parts of the nervous system.

Classification of the Rotifera.*—Dr. C. T. Hudson points out what seem to him to be the chief faults in the systems of Ehrenberg, Dujardin, Leydig, and Bartsch, and proposes the following arrangement of the Rotifers in well-marked and fairly natural groups.

ORDER I. RHIZOTA.

Fixed forms; foot attached, transversely wrinkled, non-retractile, truncate.

Fam. 1. Flosculariadæ.

Mouth central; ciliary wreath a single half-circle above the mouth; trophi uncinate.

Fam. 2. Melicertadæ.

Mouth lateral; wreath two marginal curves nearly surrounding the head, with mouth between; trophi malleo-ramate.

* Quart. Journ. Micr. Sci., xxiv. (1884) pp. 335–56 (15 figs.).

ORDER II. BDELLOIDA.

That swim and creep like a leech; foot retractile, jointed, telescopic, termination furcate.

Fam. 3. Philodinadæ.

Trochal disk two transverse circular lobes; wreath two marginal curves on each lobe with mouth between; or trochal disk of one lobe ventrally furred with cilia; trophi ramate.

ORDER III. PLOÏMA.

That only swim.

* *Illoricated.*

Fam. 4. Hydatinadæ.

Trochal disk transverse with ciliated prominences; wreath double; trophi malleate; brain small, not sac-like; foot furcate.

Fam. 5. Synchætadæ.

Trochal disk rounded; wreath of interrupted curves, surrounding the head; trophi virgate; foot absent, or minute.

Fam. 6. Notommatadæ.

Trochal disk oblique; wreath of interrupted curves and clusters; trophi virgate or forcipate; brain large, sac-like; foot furcate.

Fam. 7. Triarthradæ.

Trochal disk transverse; wreath single, marginal; trophi malleo-ramate; foot absent.

Fam. 8. Asplanchnadæ.

Trochal disk rounded; wreath single, marginal; trophi incudate; intestine, anus, and foot absent.

** *Loricated.*

Fam. 9. Brachionidæ.

Trochal disk transverse with ciliated prominences; wreath single, marginal; trophi malleate; lorica entire, simple; foot transversely wrinkled, wholly retractile, two-toed or absent.

Fam. 10. Pterodinadæ.

Trochal disk two transverse circular lobes; wreath on each double, marginal; trophi malleo-ramate; foot transversely wrinkled, wholly retractile, ending in a ciliated cup.

Fam. 11. Euchlanidæ.

Trochal disk rounded; wreath in interrupted curves and clusters; trophi sub-malleate or virgate; lorica in two parts, meeting in a furrow, or entire with additional pieces: foot jointed, feebly retractile, not telescopic or transversely wrinkled—furcate or stylate.

ORDER IV. SCIRTOPODA.

That swim with their ciliary wreath, and skip by means of hollow limbs with internal locomotor muscles.

Fam. 12. Pedalionidæ.

Trochal disk transverse; wreath two marginal curves with mouth between; trophi malleo-ramate; foot replaced by two posterior ciliated processes.

GENERA.*

1. Flosculariadæ	..	*Floscularia, Stephanoceros.*
2. Melicertadæ	..	*Melicerta, Limnias, Œcistes, Cephalosiphon, Lacinularia, Megalotrocha, Conochilus.*
3. Philodinadæ	..	*Philodina, Rotifer, Callidina.*
4. Hydatinadæ	..	*Hydatina, Rhinops.*
5. Synchætadæ	..	*Synchæta, Polyarthra.*
6. Notommatadæ	..	*Notommata, Diglena, Furcularia, Scaridium, Pleurotrocha, Distemma.*
7. Triarthradæ	..	*Triarthra.*
8. Asplanchnadæ	..	*Asplanchna.*
9. Brachionidæ	..	*Brachionus, Noteus, Anuræa, Sacculus.*
10. Pterodinadæ	..	*Pterodina, Pompholyx.*
11. Euchlanidæ	..	*Euchlanis, Salpina, Diplax, Monostyla, Colurus, Monura, Metopidia, Stephanops, Monocerca, Mastigocerca, Dinocharis.*
12. Pedalionidæ	..	*Pedalion.*

Echinodermata.

Constitution of Echinoderms.†—C. Viguier, after a reference to the belief that Echinoderms are radiated animals, discusses the view propounded by Duvernoy and forcibly enunciated by Häckel, against which he has already raised some objections, and side by side with which he now pits the doctrine of Perrier taught in his work on 'Colonies Animales.' According to the view of Perrier, the Echinoderm is indeed a colony, but, instead of being formed of five equivalent individuals (antimeres), it consists of five reproductive individuals grouped around a nutrient individual; these may coalesce in various proportions. All Asteroidea are fragile, and all enjoy the power of

* "The principal ones; several of Ehrenberg's are omitted for various reasons that cannot here be detailed, and the genus *Notommata*, though the name is retained, is here supposed to have lost a large number of Ehrenberg's species."

† Comptes Rendus, xcviii. (1884) pp. 1451–3.

repairing broken arms; this rupture is often followed by a process of reproduction, numerous cases of which are already known. These facts may be as easily explained by the theory of Häckel as by that of Perrier, but there are others which can only be explained by the latter.

The hard parts around the mouth are, it is well known, very difficult to homologize with the ambulacral and adambulacral ossicles of the arms; but it is necessary to do this, if we regard the disk as nothing more than a fused part of each of the arms. On the other hand if either disk is an independent piece no homology is possible.

We sometimes find specimens in which a broken arm becomes bifurcated at its free end; if the buccal angles were merely formed by the union of the pieces of two neighbouring arms (as ought to be the case on Häckel's theory) it is difficult to see why the angle of bifurcation should not be formed in just the same way. On the other hand, if the peristomial skeleton belongs to a central individual it is evident that an arm could not produce along its own course pieces similar to those of the central piece—the odontophors or the teeth. Between the oral angle and the angle of bifurcation at the free end differences may be observed in the spines, which in the latter are exactly like the adambulacral and different from the longer ones found at the angle of the mouth; the brachial angle is formed by adambulacral pieces, which are very different from the large truncated teeth of the peristome; and, lastly, the odontophor which is so characteristic a part of the disk, is altogether wanting at the angle of the brachial bifurcation. The author adduces photographs in support of these statements.

Pourtalesia.*—Professor S. Lovén, the veteran author of the 'Etudes sur les Echinoidées,' has made another important contribution to the morphology of the Echinoidea, based on a study of the characters of the remarkable deep-sea genus *Pourtalesia*.

The first chapter deals with the general form of the skeleton, which, as in all Echinids, is a hollow sac inclosing the visceral organs, and constituted by three distinct systems—ambulacral, perisomatic or interradial, and calycinal or apical. The mode of numbering suggested in the 'Etudes' is here again made use of. Whenever this skeleton has been accurately studied it has been found that its constituent elements are, in reality and fundamentally, arranged bilaterally and symmetrically on either side of the mesial plane, indicated by its antero-posterior axis. The archæonomous or old-fashioned type of the Clypeastridæ as well as the neonomous or new-fashioned Spatangidæ give distinct indications of the bilateral form of the adult. Though more difficult to detect, this bilaterality obtains also in the ancient Cidaridæ, and we have here "another instance of the validity of one of the laws more than once ascertained to underlie evolution, namely, that structures which are to be gradually but forcibly worked out during the course of geological ages into specialized and highly characteristic features, are virtually present within the fabric of the

* K. Svenska Vet. Akad. Handl., xix. (1883) 95 pp. (21 pls.) (written in English).

earlier forms, though dormant, and, as it were, lying in abeyance, and to be detected only by a close scrutiny."

The general form of *Pourtalesia* is unlike that of any other known Echinid; it has the form of an inverted short-necked bottle; from the side the anterior line is seen to be bluntly truncated, while the dorsal surface is marked posteriorly by a deep depression, behind which there is a truncated caudal prolongation. Anteriorly the test is suddenly bent inwards and backwards, so as to form a deep ovoidal recess leading to the mouth. It would seem as if "this anomalous configuration" were due to "the dorsal portion of the body having moved forwards beyond the normal measure, and so as to leave behind the subanal part of the ventral portion, and as though its forepart produced into a rostrum projecting ventrally and compressed from both sides, had been drawn, by invagination, into the peritoneal cavity."

The perisomatic portion is next dealt with, and here perhaps we have the most anomalous condition of parts, for it is found that two of the interradii unite in the middle line and so form a continuous broad ring passing round the middle of the body; this arrangement appears also to be found in *Spatagocystis*, but it is only seen in *P. jeffreysi* and *P. laguncula* among the species of the genus *Pourtalesia* as defined at present. Lovén makes the interesting remark that "once before, early in Mesozoic time, for a while and not unlike a trial soon given up, a structure resembling this was seen in the Collyritidæ, but imperfect, the ring being open ventrally and closed dorsally only." As it obtains in *P. jeffreysi*, the author thinks that the radiate disposition of the skeletal elements is destroyed in an essential degree, "and a tendency betrays itself towards an annular differentiation of the bilaterally symmetrical constituents of the cylindroid skeleton."

The peristome likewise presents us with some very extraordinary characters; the structure of which leads us to think "that what is going on here may be looked upon as the first move, so to speak, towards forming a rudimental mouth, a *cavum oris*, the invaginated parts of which, if they were flexible and provided with muscles, might be protruded like a proboscis." Without here going into details we can only say that the author establishes his proposition that the joint participation of the ambulacra in the formation of the peristome, and the uninterrupted sequence of their plates does not obtain in the genus under consideration.

The characteristic sensory organs (sphæridia) first detected by Lovén in the region of the mouth of Echinids, are not, as in most, arranged in *Pourtalesia* in all the five ambulacra, but are absent from No. III., or that which is anterior and odd. In *Pourtalesia*, however, the ambulacrum in question is raised above the level of the peristome, so that we see that "of whatever nature the special changes in the surrounding water may be that their ciliated epithelium has to watch for, these changes seem to be of essential moment to the animal, solely when they take place in the vicinity of the mouth, or between the under surface and the ground on which the animal has to find its food."

The author next enters on an elaborate account of the structure of the pedicels of the Echinoidea, into the details of which our space prevents us following him.

The next chapter deals with the important subject of the calycinal system, which he defines as consisting of a central ossicle, five costals, and five radials; he urges with much point the value of using these terms, and says truly that, when we know more "the final terminology will come of itself." The differences between the Crinoid and the Echinoid organization are sharply pointed out, and it is shown that in the latter the system "is rendered, to no small extent, a disputed ground, each of these (generative, water-vascular, anal) organs tending to penetrate its substance and gain access to the surrounding water." *Tiarechinus*, with its enormous calyx, appears to be the most antique of Echinoids. While a number of forms retain a stable relation of the parts we find that, when this is disturbed, the anal orifice is the first to alter its position; it is followed by the madreporite and generative pores, but the eyes remain stationary. The various stages of changes are traced in the most interesting and instructive manner, and the whole history thus philosophically summed up. "A large and powerful structure, closely specialized for a function of fundamental importance in the economy of some remote ancestral type, is inherited, in an early state, by a descendant in which, from a total change in the mode of life, the very purpose no longer exists for which it was originally contrived, and to which its parts were adapted. It long retains certain marked features which even to this day reveal its origin, but, unlike its crinoidean sister-structure which, with functions unaltered, multiplies its components—it remains simple as from the beginning, and, superfluous as it has become, gradually declines in intrinsic vigour, and is given up to subserving activities that had no share in its previous existence. Invaded by contending organs and yielding to their various tendencies it has its parts deeply modified and even to some degree suppressed, and, although still true to its type, and asserting, so to say, its unimpaired independence by redintegrating its injured frame, it dwindles, nevertheless, from age to age in every succeeding form, and is seen to fall into decay and dismemberment and to lose one by one its characteristics, till at last little remains of its original constitution.

In trying to sum up the characters of the Pourtalesiadæ the author feels the difficulty that the species which he has been able to study most completely, *P. jeffreysi* is of a more advanced character than the rest, but justly remarks that "this is not the first occasion, nor will be the last, when a species that chances to be the most familiar to us is put forward as the type of its kind." The general form of the skeleton is subcylindroid, truncated anteriorly, tapering posteriorly; there is a deep infrafrontal recess and a rudimentary buccal cavity. Bilateral symmetry is highly developed; the perisomatic system predominates, while the calycinal is verging on decay. The breach of continuity in two of the ambulacra is without parallel among the members of the class. Like the Echinoneidæ they are

alone among the neonomous Echinoids in having homoiopodous pedicels, none of which are disciferous or converted into respiratory leaflets. The spines are Spatangean in characters. They do not attain to the level of the Spatangidæ owing to the frequent loss of the organ of vision as well as by the simplicity of their pedicels. By some of their characters they point, though remotely, towards animals of another and higher type, animals of annulose differentiation. They are found in all oceans, and, on the average, at a depth of 2900 metres.

As to the origin of the deep-sea fauna Prof. Lovén utters these pregnant sentences: "In the adult state most of the marine Evertebrates remain at their native station, wandering within its precincts. Their embryonic and larval age is their period of dispersal. Of numerous littoral forms, of different classes, tribes, and orders, currents must occasionally carry away the free-swimming larvæ . . . . far into the sea, and during the course of succeeding generations early stages of many a species will in this way have reached the wide ocean. There they will have sunk, their development accomplished all through depths full of danger and more and more uncongenial, and a few of them will have settled on the bottom of the abyss, and fewer still will have come to thrive there. Among these some will long have their original character, and but slowly been modified, while others will have exhibited a latitude of variation unknown or rarely seen where they came from, but upon the whole there will be reasons for assuming the less altered forms to be new comers, the more deviating to be old inhabitants of the deep."

Anatomy of Larval Comatulæ.* — Dr. P. Herbert Carpenter closely criticizes some of the results lately published by Perrier.† He expresses his doubts as to the single curved water-tube of the "cystid-phase" opening to the exterior by a pore on the wall of the body, and inclines rather to Ludwig's exact account of the primary water-tube as a dependence of the water-vascular ring opening into a section of the body-cavity, into which the primary water-pore, which pierces the oral plate, also opens. He doubts also the continuity of the pore and tube in later stages of the larva.

"The most startling statement" on the part of Perrier is that the plexiform gland of Crinoids corresponds, not with the ovoid gland of Star-fishes and Urchins, but with the stone-canal of these echinoderms. The ground for this statement can hardly be histological, and it is difficult to imagine what it may be. The relations of the axial organ to the cirri can hardly be seriously maintained, unless Perrier will show that the cirrus-vessels are radial and derived from the cavities of the chambered organ. Dr. Carpenter reiterates the expression of his hope that Perrier will publish more complete accounts and illustrate them by a number of figures.

* Quart. Journ. Micr. Sci., xxiv. (1884) pp. 319–27.

† See this Journal, *ante*, p. 389.

Cœlenterata.

Notes on Medusæ.*—C. Keller has some observations on *Coty lorhiza tuberculata*, which appears at certain periods in the Mediterranean, and the habits of which invite the question, what are the causes of its regular migration, and whence does it come? From the series of observations which the author was able to make he was led to conclude that it is highly probable that this Medusa is a true deep-sea form, which only comes to the surface for a time, and spends most of its life in its sessile condition on the floor of the sea. The cause of the migration appears to be associated with reproduction, the nurses being littoral, the young Medusæ deep-sea forms, so that the sexually mature animal rises to the surface and lives pelagically. With reference to the theories that may be based upon these facts Keller quotes Carl Vogt, who has lately expressed his belief that the class Hydromedusæ has arisen from two different stocks, one of which has produced the Acraspedota and the Scyphostomata, the other the Craspedota, Siphonophora, and hydroid polyps, and who, further, has expressed his belief that fixed and parasitic creatures are always produced by special adaptation from forms that were primitively free. Though this, of course, is not true of *Comatula*, yet we must remember how infinite are the powers of adaptation, and not summarily reject it as not applicable to the Medusæ.

The yellow cells of *C. tuberculata* are next discussed, and the author declares his agreement with the views of Geddes and of Brandt that the bodies are algar in nature, and thinks that the symbiosis is explicable on the supposition that the cells in question are found only in the pelagic generative forms, which demand a larger supply of oxygen.

A new Medusa—*Orchistoma agaraciforme*—the first species of the genus found in Europe (Mediterranean), is next described. As the development of the Orchistomidæ is as yet altogether unknown, it is interesting to learn that Keller has found some young specimens; it was found that the gonads are only apparently canular, and that they really arise from a gastric outgrowth, a condition as yet unique among the Thaumantidæ or Leptomedusæ. There appears to be a considerable amount of metamorphosis; the most important changes obtaining in the radial canals, which increase in number; in the gastric cavity, which diminishes in size; and in the proportionately late development of the large gastric stalk.

Revision of the Madreporaria.†—Prof. P. M. Duncan gives a revision of the families and genera of the Sclerodermic Zoantharia, Ed. & H. or Madreporaria (M. Rugosa excepted). Since Milne-Edwards and Haimes' work of 1860, no systematic revision of the Madreporaria has appeared, while since then a great number of new genera have been founded; hence the necessity for a revision has arisen, and more especially in consequence of the morphological researches of Dana, Agassiz, Verrill, Lacaze-Duthiers, and Moseley.

* Recueil Zool. Suisse, i. (1884) pp. 403–22 (1 pl.).
† Journ. Linn. Soc. Lond. (Zool.), xviii. (1884) pp. 1–204.

In the present revision the sections Aporosa and Perforata remain, but shorn of some genera; the old family Fungidæ becomes a section with three families, two of which are transitional between the sections just mentioned. The section Tabulata disappears, some genera being placed in the Aporosa, and the others are relegated to the Hydrozoa. The Tubulosa cease to be Madreporarian. Hence the sections treated are Madreporaria Aporosa, M. Fungida, and M. Perforata. The nature of the hard and soft parts of these forms is considered in relation to classification, and an appeal is made to naturalists to agree to the abolition of many genera, the author having sacrificed many of his own founding. The criticism of 467 genera permits 336 to remain, and as a moderate number (36) of sub-genera are allowed to continue, the diminution is altogether about 100. The genera are grouped in alliances, the numbers in families being unequal. Simplicity is aimed at, and old artificial divisions dispensed with. There is a great destruction of genera amongst the simple forms of Aporosa, and a most important addition to the Fungida. The genera *Siderastreæ* and *Thamnastræ* are types of the family Plesiofungidæ, as are *Microsolenia* and *Cyclolites* of the family Plesioporitidæ. The families Fungidæ and Lophoseridæ add many genera to the great section Fungidæ. There is not much alteration in respect of the Madreporaria Perforata, but the sub-family Eupsamminæ are promoted to a family position as the Eupsammidæ.

Prof. Duncan also describes * a new genus of recent Fungida, Family Funginæ Ed. and H., allied to the genus *Micrabacia*, and which he names *Diafungia*. There is one species, *D. granulata*.

Porifera.

New Gastræades from the Deep Sea.†—Prof. E. Häckel has found among the collections of the 'Challenger' organisms which agree in the following characters; they live at the bottom of the sea (in rare cases littorally, in the majority at great depths) and have a firm skeleton formed of the substance there found, which they unite into a solid cement by means of a small quantity of organic cementing matter; some of these skeletons formed quite a museum of Radiolaria, consisting as they did of the most delicate shells of several hundred species. The skeletons are either external or internal; the former being due to the secretion of mucus from their outer surface, while in the latter the foreign bodies were taken into the ectodermal cells. In the former the secretion contains no cell-nuclei, in the latter they consist distinctly of protoplasm, in which a few, or in rare cases, a number of nuclei were to be found; we have then here to do with a more or less modified syncytium. The organisms vary much in form and size, the smallest being from 1–3 mm. in diameter, the largest from 80–120. The organisms that form the cemented skeleton may be either Protozoa or Metazoa; the former are, in a few cases, colossal *Lobosæ*, allied to *Difflugia*; in many cases they are true Rhizopoda, and the majority Thalamophora.

* Journ. Linn. Soc. Lond. (Zool.), xvii. (1884) pp. 417–9 (1 pl.).

† SB. Jenaisch. Gesell. f. Med. u. Naturwiss., 1883 (1884) pp. 84–9.

The cemental Gastræades fall into two groups, which have the same relation to one another as have the Ascones to the Leucones among the Calcispongiæ. In the simple and phylogenetically older forms, the wall of the gastric tube is thin and solid, but in the further developed it is thicker and traversed by gastric canals. The former, allied to the already described *Haliphysema* and *Gastrophysema*, are either branched (*Dendrophysema*) or plexiform (*Clathrophysema*). The latter belong to a new group called the Cæmentaria; resembling many Dysidiidæ, they are distinguished by the complete absence of ectodermal pores, so that the water only enters the irregular canal-system (the spaces of which are completely or partly invested by endodermal flagellate epithelium) by the mouth-orifices. In the endoderm there are scattered ovarian cells. *Cæmentascus* forms simple tubes, with a single oral orifice; *Cæmentoncus* has several orifices and is irregular in form; *Cæmentissa* forms flat lobate crusts; *Cæmentura* branched creeping or dendriform masses with several mouth-openings. Häckel thinks that the Orthonectida are allied to the Cyemaria, and that the *Trichoplax* of F. E. Schultze is a permanent *Discogastrula* form.

Siliceous Spicules of Sponges.*—J. Thoulet has examined the structure and other characters of the spicules of various sponges collected during the last cruise of the 'Talisman.' They were separated by treating the sponge with hydrochloric acid. The acicular spicules lost 13·18 per cent. of weight on heating to redness for ten minutes in a platinum crucible. Before the blowpipe they were whitened, or became slightly ochreous in colour, without a trace of fusion. Stellate spicules of five rays lost 12·86 per cent. on calcination. The specific gravity, obtained by flotation in a solution of iodides, was 2·032. But the spicules have a delicate tube along the centre generally less than ·001 mm. in diameter; and allowing for this, the author obtained by calculation, 2·0361 as the true specific gravity—which is that of opal.

The spicules are easily attacked by different chemical agents, so that they ought to be very readily dissolved in sea-water on the death of the animal. They were analysed after calcination by Boricky's process, by means of pure hydrofluoric acid, after first boiling in nitric acid and calcining, and they were proved to be pure silica. When not previously calcined, but simply washed, the process yielded a residue of hydrofluosilicate of soda in hexagonal prismatic crystals, the origin of which it is hard to explain unless it be that the minute tube of the spicules contains sea-water.

Fresh-water Sponges and the Pollution of River-water.†—E. Potts has examined the sponges found in the forebay of the Philadelphia waterworks when the water was withdrawn, and considers that the sarcode of fresh-water sponges does not slough off at the approach of winter, so that these organisms do not ordinarily pollute

* Bull. Soc. Mineral. France, April 1884. Cf. Amer. Journ. Sci., xxviii. (1884) p. 76.

† Proc. Acad. Nat. Sci. Philad., 1884, pp. 28-30.

the water unless torn to pieces by violent freshets. He believes that the whole of the sarcode retires into the statoblasts, from which it issues again in spring.

Protozoa.

New Infusoria.—Dr. A. C. Stokes describes * a new genus and six new species of fresh-water Infusoria.

Hymenostoma n. gen., *H. hymenophora* resembling *Lembadion*. *Trachelophyllum vestitum* with needle-shaped objects scattered throughout its substance which may be trichocysts, but their form and the action of the light suggest that they may be crystals. They closely resemble the acicular raphides of *Lemna* and other plants. *T. tachyblastum*, the specific name of which ("sprouting quickly") was suggested by the rapidity with which the animal repaired an injury it sustained by a collision with an *Oxytricha*. *Litonotus pleurosigma* resembling *L. fasciola* but differing from it and all other species of the genus in the multiple contractile vesicles. *L. helus* and *Petalomonas disomata*.

A new species of *Vorticella* (*V. Lockwoodii*) is also described † by the same writer. The characteristics by which it may be distinguished from all *Vorticellæ* are the existence and structure of the cuticular prominences and the undoubted presence of *two* contractile vesicles.

J. P. McMurrich describes ‡ *Metopus striatus* which he considers to be sufficiently distinguishable from the other species (*M. sigmoides*) to justify its being treated as a distinct species.

J. G. Grenfell records § four new Infusoria from Bristol; *Zoothamnium Kentii* differing from *Z. dichotomum* and all other species of the genus in the characteristic covering of flocculent matter; *Pyxicola annulata* ‖ very like *P. Carteri*, but differing in dimensions and undulations; *Platycola bicolor*, so named "from the two colours of the lorica" (lorica dark yellow, with a colourless neck)—it has a very delicate membranous hood which has a large oval opening, is retractile, and projects backwards from the top of the ciliary disk covering the opening; *P. aurita* (n. sp. ?).

C. L. Herrick describes ¶ *Ophridium problematicum* and an infusorian closely related to *Paramœcium*, but differing in several interesting particulars from it and its allies. In form this animal is linear lanceolate (about 0·2 mm. long), tapering posteriorly to an almost acuminate point. Anteriorly is a long vibratile proboscis, or flagellum, which exceeds, when extended, the whole length of the body. The mouth is situated at the base of this proboscis, and opens into a very short infundibulum. The whole surface of the body and proboscis is covered with minute cilia, which are inserted in rows,

* Amer. Mon. Micr. Journ., v. (1884) pp. 121–5 (9 figs.).
† Amer. Natural., xviii. (1884) pp. 829–30 (2 figs.).
‡ Ibid., pp. 830–2 (1 fig.).
§ Journ. of Micr., iii. (1884) pp. 133–8 (1 pl.).
‖ But see Dr. Leidy, this Journal, iii. (1883) p. 77.
¶ Science, iv. (1884) p. 73.

giving the body a punctate appearance. Longer cilia surround the mouth. The sarcode is transparent, and, apart from a few greenish food-balls, contained only a large number (over a dozen) of oval bodies of a similar character (endoplastules in an unobserved coiled endoplast?). The motions of the animal are very quick, and are occasioned chiefly by the whip-like motions of the proboscis, which is extremely vigorous in movement, and alters its form greatly. Apart from this rapid motion, it can propel itself slowly by means of the cilia covering the entire surface. It is the type of a new genus, and is named *Phragelliorhynchus nasutus*.

Parasitic Peridinian.*—G. Pouchet has met with a Peridinian which in its early stage is parasitic on *Appendicularieæ*. These parasites are pear-shaped, about 170 to 180 μ long, with a nucleus large in proportion. In colour they are a deep brown; they are enveloped in a thin cuticle which they keep on becoming free, whilst they abandon their pedicel. These detached individuals float in great abundance on the surface of the sea and there undergo *free* or *independent segmentation*, subdividing after the manner of a fecundated vitellus into uninucleated spheres dwindling in size and growing paler in colour as the process continues; but the products of this segmentation always remain independent. A very thin cuticle is thrown off as they divide. The spheres finally resulting, measuring no more than 10–13 μ, develope a long flagellum and a crown of cilia, and become minute Peridinians allied to *Pulvisculus* of Ehrenberg (*Gymnodinium pulvisculus* of Bergh). The whole process occupies about 24 hours.

Observations on Flagellata.†—F. Blochmann commences with some notes on *Trichomonas vaginalis*, at the anterior end of which there are three flagella, from the base of which an undulating membrane extends to about the middle of the body; this membrane, never hitherto observed, may be best seen if the creature is allowed to die gradually. The *T. batrachorum* of Perty (the *Cimœnomonas batrachorum* of Grassi) is next considered, and here also an undulating membrane was detected. If the monad is allowed to remain for some time under the pressure of the cover-glass the whole margin of the animal is seen to exhibit an active undulatory movement, though, of course, this is not so regular as that of the membrane. A similar phenomenon is to be observed in *Trichomastix lacertæ*, a species lately detected by Bütschli in the cloaca of *Lacerta agilis;* it has four flagella, one of which is half as long again as the animal and is directed backwards. *Oxyrrhis marina* is the last form described; within their bodies a large number of fat-drops, often of considerable size, are to be detected; they take in solid nutriment. The author was able to observe their multiplication by a mode of transverse division.

Geometry of Radiolaria.‡—Prof. E. Häckel points out that the four orders of the Radiolaria are distinguished by their geometric

* Comptes Rendus, xcviii. (1884) pp. 1345–6.
† Zeitschr. f. Wiss. Zool., xl. (1884) pp. 42–9 (1 pl.).
‡ SB. Jenaisch. Gesell. f. Med. u. Naturwiss., 1883 (1884) pp. 104–8.

form; in the Acantharia we have the quadrate octohedron, where twenty radial spines are arranged in five sets of four spines each, which are set quite regularly in meridional planes. In the Nassellaria or Monopyleæ there is at first a monaxial form, which is in many cases rendered bilaterally symmetrical; this is true also of the Phædoria or Tripyleæ. Stereoscopic forms are seen in the Spumellaria.

The Sphæroida, which may be regarded as the stem-form of all Radiolaria, ordinarily retain the spherical form of the central capsule, and frequently give rise to the endosphæric polyhedron; from these, more complex forms arise by the development of spines along certain rays. The Prunoidea are at first monaxial ellipsoids, and they finally produce the much more complex Zygartidæ. The Discoidea arise from the Sphæroida by the shortening of the vertical primary axis, and they at first have the form of biconvex lenses. The Larcoidea begin with simple ellipsoid shells, and become complicated by the development of further systems of network.

Polythalamian from a Saline Pond.*—E. v. Daday describes a new genus—*Entzia*—of Polythalamians from saline waters, which have been studied by Prof. Entz, who finds that the infusoria living therein are new forms, or have as yet been found in the sea only, or are common to both fresh and sea water, while a fourth of the whole number are only known as fresh-water forms. The new genus is characterized by having a multicamerate imperforate shell, which contains a large number of siliceous plates; the chambers are coiled from left to right, and are only completely visible from the convex side; at the outer partition of the terminal chamber there are larger orifices, which are oval and tubular, and two smaller which are circular. *Tetrastomella* is proposed as the specific name.

In the form of its shell *Entzia* resembles *Rotalia*, and belongs to the group of the Helicostegia; the largest of the 16-chambered individuals measured 0·42 mm., while the smallest 6-chambered shell measured only 0·08 mm. As in *Rotalia*, the partitions between the chambers were formed of two lamellæ, one belonging to the chamber in front and the other to that behind, but there is not here any interseptal space; in all, as in the last partition, there are two large and two smaller holes. As the siliceous plates are completely imbedded in the substance of the shell, the surface of the latter is, notwithstanding their presence, quite smooth; they cannot, therefore, be regarded as foreign bodies, but must be supposed to have been formed by the protoplasm. On the whole, an investigation into the characters of the shell shows that it unites peculiarities which are separately characteristic of chitinous and arenaceous Rhizopods, and the close allies of the form are to be found not so much in *Rotalia*, which it resembles in appearance, as in *Difflugia* and the arenaceous Mono- and Polythalamia. The author sums up his views as to the systematic position of *Entzia* in the

* Zeitschr. f. Wiss. Zool., xl. (1884) pp. 465–80 (1 pl.). Cf. Gruber's note, this Journal, *ante*, p. 580, which should have followed the above.

following terms: It is the only as yet known continental Polythalamian, and in the form of its shell resembles that of the sub-family Rotalinæ of the group Globigerinæ; in structure the shell resembles that of *Trochammina;* in the structure of its partitions it agrees with the perforate Polythalamia; in that of the orifices of these partitions with the Lagenidæ; the chemical constitution is that of *Difflugia*, *Trochammina*, and some of the Globigerina, and it closely connects the last with the Lagenidæ by means of *Trochammina* and the Rotalinæ.

Nuclear Division in Actinosphærium eichhornii.*—R. Hertwig concludes from his observations on the resting nucleus that the coloured constituents of the nucleus (chromatin or nuclein) are not spongy bodies; all the nuclein is contained in nucleoli, which are stained by reagents. A subject of greater difficulty is presented by the parts which are formed in addition to the nucleoli within the nucleus. These are (1) the granulation which becomes visible on the addition of reagents; (2) the paranuclear pieces which in the fresh condition are seen to have various forms; (3) the highly refractive corpuscles; and (4) the nuclear membrane. The first three appear to be referable to a common structure of colourless substance, which may be called paranuclein or achromatin, and which fills up the interspaces between the nucleolus and the nuclear membrane. It may be regarded as due to special thickenings of the achromatic network. The author is acquainted with essentially similar phenomena, which have presented themselves in the nuclei of insects, and of which he will give an account at a later period.

The mode of division of the nucleus, as seen in *Actinosphærium*, is intermediate in character between what is seen in plants and animals on the one hand, and in Protozoa on the other; in the latter, which approach most nearly the diagrammatic scheme, the biscuit-shaped constriction of the nucleus is most apparent; internal differentiations of the nuclear substance are either completely wanting, or are nearly fibrillar. (An exception to this is seen in the paranuclei of the Infusoria.) On the other hand, in plants and animals the biscuit-shaped constriction is obscure, the limits of the nuclear substance and protoplasm disappear, and there is a mixture of the two substances. The whole division of the nucleus appears, therefore, as a complicated and extremely regular rearrangement of the nuclear particles, which lead to the important differentiation of achromatic nuclear filaments and of chromatic elements; the two substances are so sharply separated that they might be taken for elements which had nothing to do with one another.

In *Actinosphærium* we have, as in the other Protozoa, those changes in form which the whole nucleus undergoes during division; but as to its internal structure there are many points in which the nucleus resembles that of animal ova; a nuclear plate is formed, which divides into lateral plates that separate from one another and the parts of the lateral plates give rise to achromatic filaments. Before the appear-

* Jenaisch. Zeitschr. f. Naturwiss., xvii. (1884) pp. 490–517 (2 pls.).

ance of the nuclear plate there is a stage in which it resembles that of the Infusoria; as in them, bands, which may be coloured for their whole extent, reach from pole to pole. This would seem to show that in *Actinosphœrium* the achromatic filaments contain particles of chromatin throughout their whole extent, and the same is probably true of the Infusoria.

In addition to the interest which surrounds the nucleus of *Actinosphœrium* in consequence of its intermediate position, the mode of formation of the lateral plates is also of interest. The view of Flemming that in animal cells these plates are primitively laid down separately does not apply to *Actinosphœrium*, where the first rudiment of the nuclear plate is a single row of granules. The nucleus is also distinguished by the possession of polar plates, or aggregations of homogeneous substance which are interpolated between the striated part of the nucleus and the homogeneous protoplasmic cones; they appear to be derivatives of the cell-nucleus, formed by the clearing up of its peripheral parts. The nuclear filaments are distinguished from those of animal and vegetable cells by their finely granular condition; they appear to consist of paranuclein, together with minute remnants of colourable nuclein.

Parasite of the Wall of the Intestine of the Horse.*—M. Flesch gives an account of a parasite which he has proposed to call *Globidium leuckarti*, and which was found particularly in the connective tissue of the intestinal villi of the horse, where its presence may give rise to subacute inflammation. It ordinarily has a spherical or ellipsoid body sharply marked off by its capsule; in most cases its wall is hollowed by a special fusiform or semilunar cavity, which is completely filled by a granular body or, as the author calls it, the accessory body. In position it resembles the remains of the yolk in the ova of *Tœnia*. In another form the refractive spherules in the interior of the parasite were solely parietal in position, and the central space was occupied by a protoplasmic mass, which was very uniformly granular. The author describes the stages in development that he was able to observe, and then addresses himself to the question as to whether he had here to do with a phase in the alternation of generations of a higher organism, or whether the parasite was a Sporozoon. He next gives a list of the known parasites of the horse, which, as being fuller than that of Linstow, may be of use for other purposes, and discusses the probabilities of his new form being a stage in the life-history of any one of these; this view being rejected he addresses himself to the Sporozoon-view, against which it seems there is nothing to be said, but in favour of which there is almost as little; in fact it is, at present, impossible to assign a definite position to the parasite. The relatively large capsules, and their position in the connective tissue are against its being a Sporozoon; the part played by the accessory body is unknown, and the evidence as to its being expelled from the organism is incomplete. The author hopes to be able to make further and more complete investigations and meanwhile proposes

* Recueil Zool. Suisse, i. (1884) pp. 459–89 (1 pl.).

to speak of this obscure and abnormal parasite by the name he originally suggested of *Globidium leuckarti*.

Sutherlandshire "Eozoon."*—Prof. M. F. Heddle, after a careful examination of the Eozoon-like structure that occurs in the marbles of Assynt, recalls his previously expressed opinion as to its non-mineral character and attributes to it a purely inorganic origin. The greater part of this structure is formed of dark serpentine with some magnetite, whilst in the calcareous layers are imbedded fibres apparently of wollastonite. Prof. Heddle states in a footnote that having unravelled the Scottish Eozoon, he entered upon an inquiry into the Canadian, in which he finds nothing he did not see in the Scotch specimens; at the same time the specimens examined were possibly not good examples.

BOTANY.

A. GENERAL, including Embryology and Histology of the Phanerogamia.

Continuity of Protoplasm.†—P. Terletzki has investigated this question with a view of determining what organs and what tissues in the same plant display the phenomenon. For this purpose he has taken in the first place *Pteris aquilina*, and has found a distinct protoplasmic connection, in the rhizome, between the parenchymatous cells, the conducting cells, and the sieve-cells, in each case among one another, and between the sieve-cells and the conducting cells. On the other hand, he could detect no connection in the following cases:—between the cortical cells among one another, between the cortical and parenchymatous cells, the cells of the supporting bundles among one another, the supporting bundles and the parenchyma, the cells of the protecting sheath among one another, the protecting sheath and the parenchyma, the protecting sheath and the conducting cells, the bast-cells among one another, the bast-cells and the conducting cells, the bast-cells and the sieve-cells, the conducting cells and the scalariform vessels, the conducting cells and the tracheids (annular or spiral conducting cells). These remarks apply to the mature condition of the plant, and it is possible that in the cambial condition the protoplasm of the whole of the cells may be in connection.

The general facts were the same in other organs of *P. aquilina*, and in other ferns.

Protoplasm was found in the intercellular spaces, especially in the parenchyma of the rhizome, also in the parenchyma of the leaf-stalk; and this intercellular protoplasm was in connection with the cellular protoplasm.

* Mineral. Mag., v. (1884) pp. 271-324 (11 figs.).
† Ber. Deutsch. Bot. Gesell., ii. (1884) pp. 169-71.

Continuity of Protoplasm.*—G. Schaarschmidt believes that all vegetable cells inclosed in a cell-wall and combined into a tissue are placed in uninterrupted connection by means of threads of protoplasm.

With regard to the occurrence of protoplasm in intercellular spaces, he finds intercellular masses of protoplasm in *Liriodendron tulipiferum*, also in the bud-scales of *Æsculus Hippocastanum*, in *Solanum Pseudocapsicum*, *Viscum album*, &c. They occur especially where the cells themselves contain no great quantity of protoplasm, and can convert themselves into true cells by becoming invested with a cell-wall; secondary intercellular spaces are then formed between these and the older cells. This intercellular protoplasm the author believes to be derived from the threads which pass from cell to cell.

Osmotic Power of Living Protoplasm.†—By an ingeniously contrived apparatus M. Westermaier claims to have proved that the pressure of the parenchymatous cells of the root-system, and the osmotic suction of the protoplasm in the parenchyma of the stem, acting together, are capable of raising a column of water to any given height from the soil.

Structure of Pollen-grains.‡—J. Vesque points out that the pores in the pollen-grains are so arranged that, no matter in what position the grains fall on the stigma, one at least of the pores is ordinarily in contact with the moist membrane of the stigmatic papillæ. The larger the grain the greater the number of pores (or of folds), and their number, therefore, cannot be considered of great taxonomic value. M. Vesque has found pollen-grains of *Hieracium* having three to four pores, and that in the same anther.

The disposition of the external ornamentation of the pollen-grain does not appear to depend on its mode of development, but on a fixed geometrical law—that of phyllotaxy. Thus the complex pollen-grain of the Chicoraceæ, were it completely spherical, would be a pentagonal dodecahedron; but as it is slightly ellipsoid, hexagonal network is combined with the pentagonal. In the simplest case, that which obtains in *Scolymus*, three hexagonal faces furnished with pores are seen on the equator of the grain, the twelve remaining faces being pentagonal. It is evident that the number of hexagonal faces increases the more the grain approaches the cylindrical form. Thus in *Sonchus*, *Helminthia*, and *Lactuca* it has twenty-one faces, three hexagonal ones with pores, six without, and twelve pentagonal ones.

Seeds of Abrus præcatorius.§—W. Tichomiroff classifies the seeds of Papilionaceæ hitherto examined into three classes, according to the nature of their reserve material, viz.:—(1) Seeds containing a fatty oil, starch, glucose, and aleurone, such as *Arachis hypogæa* and *Dipterix odorata*; (2) those containing starch and aleurone only, as

* Magy. Növ. Lapok, viii. (1884) pp. 17–20. See Bot. Centralbl., xviii. (1884) p. 162.

† Ber. Deutsch. Bot. Gesell., i. (1883) pp. 371–83.

‡ Comptes Rendus, xcvi. (1883) pp. 1684–6.

§ SB. Vers. Russ. Naturf. u. Aerzte, Aug. 25, 1883. See Bot. Centralbl., xviii. (1884) p. 189.

Pisum sativum, *Phaseolus multiflorus*, and *Physostigma venenosum*; (3) those containing coarsely granular aleurone and a fatty oil, as *Lupinus mutabilis* and *Trigonella Fœnum græcum*. Those of *Abrus precatorius* constitute a distinct type; they contain a fatty oil and albuminoids in the form of finely granular protoplasm, but neither aleurone nor starch. Another characteristic is the persistence of the nucleus and nucleoli in the peripheral parenchymatous layers of the cotyledons. The crystals sometimes found in the parenchymatous cells destitute of nucleus may consist of stearic acid or hesperidin. The cell-wall is thickened in a porous manner, is not doubly refractive, and consists of pure cellulose. The testa is composed of four layers, viz.:—(1) rods, colourless in the red part of the seed, while in the black spot they are of a purple-violet colour; (2) palisade-cells, distinguished by their length, their branching, and by the folding and small diameter of their lower end; (3) parenchyma, composed of cells elongated in the tangential direction; (4) albumen, the cellular nature of which is clearly defined in the first layers, while the cells at a greater distance lose their individuality by becoming flattened radially, and at length coalesce into a homogeneous pellicle, which cannot be decomposed into its separate cells even by maceration in chromic acid. In caustic potash this pellicle swells up strongly, and forms local projections. The hilum has two of the layers of rods, but no palisade-cells, these being replaced by sclerenchyma. With the exception of the albuminous layers the cell-walls display distinct cellulose-reaction. By chloride of iron the presence of tannins can be recognized in the albuminous layers and rods.

Comparative Anatomy of Cotyledons and Endosperm.*—J. Godfrin states, as a general result of a comparison of the structure of the embryo and the endosperm, that those embryos the cotyledons of which contain starch, whether alone or together with aleurone, are never accompanied by endosperm. Those, however, which contain no aleurone, even when thick (as *Amygdalus*, *Armeniaca*, *Prunus*, *Corylus*, *Juglans*, *Carya*, &c.), may contain an endosperm, which is however always very small. Embryos with thin or foliaceous cotyledons, are not necessarily accompanied by endosperm, as witness *Hedysarum sibiricum*, *Casuarina quadrivalvis*, *Grevillea robusta*, *Hakea saligna*, and *Acer*.

The author classifies cotyledons under two heads: thick or tubercular, and thin or foliaceous. The former, when mature, have a simple epidermis without stomata or hairs, and in the interior a thick parenchyma with large globular cells, between which are a number of air-cavities. On germination very little modification of the tissues takes place. Foliaceous cotyledons have, when mature, a simple epidermis, often provided with stomata more or less developed; the parenchyma is much smaller in mass, but is always divided into two distinct layers. They vary greatly in their mode of development during germination. In those which contain aleurone its absorption is the first indication of germination.

* Bull. Soc. Bot. France, xxxi. (1884) pp. 44–51.

Underground Germination of Isopyrum thalictroides.*—This species presents one of the few examples of underground germination among flowering plants. A. Winkler has examined the process in its various stages, and points out that it exhibits a difference from the similar phenomenon in *Anemone nemorosa* and *ranunculoides* belonging to the same natural order. While in *Anemone* the unstalked cotyledons project from the testa of the seed, and, as in typical dicotyledons germinating above the surface of the soil, are opposite to one another, in *Isopyrum* they remain inclosed within the testa, and are placed on tolerably long stalks.

Stomata of Pandanaceæ.†—R. F. Solla has closely studied the stomata in the leaves of a large number of species of *Pandanus*, and distinguishes three types:—(1) the simplest and most common form, represented by *Pandanus inermis*, in which the cells contributing to its formation are only two in number; (2) the type of *P. graminifolius*, which occurs only in a few Pandanaceæ; the auxiliary cells, eight in number, are all thickened, their apices thus forming a protuberance which rises above the level of the epidermal cells, the walls of the latter being also thickened; (3) the type of *P. utilis*, resembling the stomata of *Aloe* and other allied plants; the thickening here extends from the auxiliary cells to the epidermal cells to such an extent as to form little lumps on the surface, completely concealing the outline of the stoma. A number of measurements are given of the size of the stomata in different species, and of the relative number found on a unit of superficies.

Changes in the Gland-cells of Dionæa muscipula during Secretion.‡—According to W. Gardiner there are four periods in the process of digestion by the leaves of the Venus's fly-trap, viz. the resting, the secreting, the absorbing, and the period of recovery.

In the resting stage the gland-cells exhibit the following structure:—In each cell the protoplasm is closely applied to the cell-wall, leaving a large central vacuole, which is filled with the usual pink cell-sap. The protoplasm is very granular, especially round the nucleus, which is situated at the base of the cell, and is large and well defined. At the end of the secreting period, which appears to be about twenty-four hours after stimulation, movements of the protoplasm have taken place, in consequence of which the nucleus now occupies the centre of the cell; numerous strands of protoplasm radiate from the nucleus to the parietal protoplasm, dividing the vacuole into several smaller ones. The protoplasm is now nearly homogeneous, clear and hyaline, and the nucleus has become much smaller. In the ordinary leaf-tissue special cell-contents make their appearance after the absorption of the food. About thirty-six hours after feeding the cells contain a large number of tufts of crystals in the vacuole, which adhere to the inner surface of the protoplasm. They consist of fine acicular crystals, which crystallize out with great regularity, and radiate from a central point. They are of a

* Flora, lxvii. (1884) pp. 195–8 (1 pl.).
† Nuov. Giorn. Bot. Ital., xvi. (1884) pp. 171–82 (2 pls.).
‡ Proc. Roy. Soc., xxxvi. (1884) pp. 180–1.

yellow-green colour, insoluble in alcohol, in 1 per cent. acetic acid, and in 1 per cent. hydrochloric acid, soluble with difficulty in 5 per cent. solution of potash. After forty-eight hours the cell-contents are of a different nature. The cells now contain numerous bodies which present the appearance of flat sphærocrystals. They are usually perfectly circular in outline, and are clear and colourless, insoluble in alcohol, but extremely soluble in water.

In *Drosera* similar changes take place, but much more rapidly.

Septal Glands of Monocotyledons.*—P. Grassmann describes the nectar-glands found in the septa of the ovary, which are peculiar to Monocotyledons, and in them occur only in the series of Liliifloræ and Scitamineæ. They occur one in each septum, and therefore almost invariably three in each ovary. The gland forms in the septum a fissure of varying size and form, visible even to the naked eye. It usually occupies the greater part of the septum, and is bounded on each side by a secreting layer, consisting of from two to three rows of cells. In the same family they are very constant in form and size. The glands are filled with nectar, which escapes by means of a narrow canal to the receptacle, the mode of escape varying according as the ovary is superior, half-inferior, or inferior.

The glands are formed by the incomplete cohesion of the carpels in the septa; they are recognizable at a very early stage of development, and are then quite destitute of nectar, and the stages of cohesion can be very readily followed. Their object is unquestionably the attraction of insects to assist in fertilization. They are found only in species with conspicuous flowers; the nectar always contains grape sugar, and, when it flows out of the glands, either collects on the receptacle or unites with the juice flowing from nectaries in other parts of the flower. It begins with the opening of the flower, and usually lasts several days. The canal is also surrounded by secreting cells which pour out nectar.

Secretory System of Compositæ.†—According to P. Van Tieghem, the secretory system of Compositæ presents itself in three different forms—as oleiferous canals, as anastomosing laticiferous cells, and as long, isolated resiniferous cells. Disregarding some transitional forms, the first of these types is characteristic of the Radiifloræ, the second of the Liguliflorae, and the first and third of the Tubuliflorae. The present paper is devoted especially to the situation and structure of the laticiferous network of the Liguliflorae, which he finds to be situated in the layer of cells previously denominated by him the *pericycle*, situated between the endoderm and the first sieve-tubes of the fibrovascular bundles of the central cylinder. This network does not belong to the liber, being separated from the sieve-tubes which constitute the outermost portion of it by the entire thickness of the sclerenchymatous bundle. From here it may extend right and left, and may even penetrate between the liber and the sclerenchyma, the

* Flora, lxvii. (1884) pp. 113–28, 129–36 (2 pls.).
† Bull. Soc. Bot. France, xxx. (1884) pp. 310–3.

internal cells of the pericycle remaining for a time in a merismatic condition, and then becoming differentiated here and there into laticiferous cells.

The isolated resinous cells of the Tubuliflorae, which contain a laticiferous and resiniferous secretion, occupy precisely the same position, differing from them only in their form and in their mutual relations.

Chemical Constituents of Plants.*— M. Ballo is of opinion that oxalic acid has a much more important function in vegetable physiology than is generally supposed; the carbohydrates being formed from the reduction of this and other vegetable acids rather than by direct synthesis from carbonic acid and water. Tartaric acid, on the other hand, is a product either of the oxidation of carbohydrates or of the reduction of oxalic acid, as is also the glycolic acid which occurs in unripe grapes and in the leaves of the wild vine. As regards all other products of oxidation, the less the amount of oxidation, the more complicated is the product and the more nearly related to the original substance; while, when oxidation is carried on further, we get the original substances by which the plant is nourished. The vegetable acids are the most common products of oxidation in the plant. A portion of the oxalic acid is used in the decomposition of calcium sulphate, the rest as the raw material for the production of glycolic, tartaric, malic, succinic, and other acids.

If formic acid is heated with nitric acid, it is oxidized into carbonic acid and water, the nitric acid being reduced to nitrous oxide; but at the commencement of the process oxalic acid is formed; and the author believes that this process takes place in nature, according to the equation :—

$$2\,H_2\,CO_2 + O = H_2\,C_2\,O_4 + H_2\,O;$$

and that this is one of the reasons why nitrates are so valuable to the growing plant. In the living plant a portion of the nitrates is used in the production of ammonia and other substances nearly related to it, and another in the conversion of amide-compounds into alcohol-compounds. The greater part is reduced to the state of nitrous oxide; and from this nitric acid is again formed through the agency of oxygen and water. Hence a small quantity of nitrates can bring about the formation of a large quantity of oxalates.

Electric currents exist without doubt in the living plant, and it is possible that in some cases these may be converted into chemical work consisting in the decomposition not merely of water but also of salts. The products of decomposition of these salts may cause the formation of metal-derivatives at the negative pole, of derivatives with negative radicals at the positive pole. Elsewhere these substances may again combine with one another, and the same process be then again repeated. Hence the comparatively small quantity of inorganic salts found in plants.

* Ber. Deutsch. Chem. Gesell., xvii. (1884) p. 6. See Naturforscher, xvii. (1884) p. 123.

Structure of Leaves.*—E. Mer has studied the cause of the different forms of cells in terrestrial and in aquatic leaves. The structure of a leaf with a well-developed blade and petiole, in which the normal position of the former is horizontal, is due to its situation. The upper face receives a large amount of light, and is in consequence well nourished, and the cells of the upper parenchyma acquire a great increase in length, or become palisade-cells. The epidermal cells of the upper surface, well nourished in consequence of their vicinity to the assimilating parenchyma, increase actively and regularly, and acquire polyhedral forms, with thick walls and a still thicker cuticle; the active development of which they are the seat prevents the accumulation in them of food-materials and the formation of stomata. The parenchyma of the lower surface receives less light and is in consequence less well nourished. Its cells grow transversely, and finally separate, leaving between them larger or smaller lacunæ; their walls sometimes become slightly wavy. The cells of the hypodermal layer of the lower surface do not increase in length transversely nearly so much as those of the upper surface, and even become rounded.

The hairs originate in the bud, and chiefly on the lines of maximum nourishment, the veins. The stomata always make their appearance at the end of the hyponastic or commencement of the epinastic period, during that phase of development included between the commencement of the increase in length of the palisade-cells, and the appearance of the waviness in the epidermal cells of the lower surface.

In the submerged leaves of aquatic plants the sinuosity of the walls of the epidermal cells is due to insufficiency of nutriment.

Transparent Dots in Leaves.†—P. Blenk has made an exhaustive examination of the transparent dots in the leaves of a very large number of plants belonging to a great variety of natural orders, from the point of view of their structure and mode of development, and especially of their value in classification. He considers that too little account has hitherto been taken of their presence or absence by systematists, the anatomical structure which results in the formation of these dots being often a point of great importance, which may even be made use of in dried specimens. For example, cells with mucilaginous cell-wall in the interior of the leaf occur only in Anonaceæ and Laurineæ, and may possibly indicate a close relationship between these orders.

The various causes of transparent dots or lines in leaves are the following:—Secreting cells, round intercellular secreting spaces of either lysigenous or schizogenous origin, secreting passages, epidermal or parenchymatous cells with mucilaginous cell-walls, cells containing mucilage, raphides-cells, cells with single crystals or clusters of crystals, cystoliths, spicular cells, branched sclerenchymatous bundles, groups of sclerenchymatous cells, depressed pits with or

* Bull. Soc. Bot. France, xxx. (1883) pp. 110–30.

† Flora, lxvii. (1884) pp. 49–57, 97–112, 136–44, 201–10, 223–5, 275–83, 291–9, 339–49, 355–70, 371–86.

without hairs, crevices in the tissue, stomata. The secreting cells, spaces, or passages may contain resin, gum-resin, balsam, or an essential oil.

Secreting cells are an extremely common cause of transparent dots, and are usually characteristic of whole families or at least of genera. Round intercellular secreting spaces may be lysigenous, as in Rutaceæ, or schizogenous, as in Hypericineæ, the two kinds showing no difference in the mature condition. Both kinds are of great importance from a systematic point of view, furnishing distinguishing characters for entire families. Thus lysigenous secreting spaces occur in the Rutaceæ, Myoporineæ, and Leguminosæ; schizogenous are constant in the Hypericineæ, Myrsineæ, Samydeæ, and Myrtaceæ. Intercellular secreting passages of schizogenous origin cause transparent lines in a number of Guttiferæ, and in some species of *Hypericum*.

Epidermal cells in which the inner wall next the parenchyma of the leaf is strongly thickened and mucilaginous cause pellucid dots in a number of families and genera. Cells in the interior of the leaf with all the cell-walls strongly mucilaginous occur in Anonaceæ and Laurineæ, but not in all the species. Cells with mucilage in the interior are found in the Ampelideæ, and especially in the American species of *Cissus*.

Raphides-cells are of great importance systematically. They are sometimes replaced by cells with single very long prismatic crystals. Transparent dots caused by cystoliths occur in *Ficus*, *Momordica*, and some Acanthaceæ.

Of sclerenchymatous elements the most common are spicular cells. Round groups of sclerenchymatous cells also occur, and elongated sclerenchymatous bundles; but all these forms are of comparatively small value systematically. Stellately branched sclerenchymatous bundles, the so-called "internal hairs," are constant in *Nymphæa* and in the genus *Ternstrœmia*.

The following are only occasional causes of transparent or pellucid dots, of but little systematic importance:—Depressed pits in some Capparideæ and in *Victoria regia;* depressed glands in some Meliaceæ; rupture of the tissue in some Burseraceæ, in *Nyssa capitata* and *Placodiscus leptostachys;* cells with sphærocrystalline deposits of calcium sulphate, sodium oxalate, or of an organic substance of unknown nature; the meshes of the network of vascular bundles in some Capparideæ and Portulaceæ, and finally stomata.

Secretory System of the Root and Stem.*—In pursuance of previous investigations P. Van Tieghem continues his examination of the structure and position of the secretory system in the following natural orders:—Umbelliferæ, Araliaceæ, Pittosporeæ, Compositæ, Clusiaceæ, Hypericaceæ, Ternstrœmiaceæ, Dipterocarpeæ, Liquidambareæ, and Simarubaceæ. In the Umbelliferæ and Araliaceæ the system, which occurs in the roots, tigellum, and cotyledons, is

* Bull. Soc. Bot. France, xxxi. (1884) pp. 29–32, 43–4, 112–6, 141–51, 247–56.

continued indefinitely from the cotyledons into the stem and leaves, in the pericycle, more or less near to the liber of the vascular bundles, but not in the liber itself. The same is also the case in the Pittosporeæ. In the root of Ligulifloræ (Compositæ) the laticiferous network occupies the internal edge of the liber within the sieve-tubes, while in the stem it is situated in the pericycle outside the sieve-tubes. In those Tubulifloræ which possess a secreting system, its position in the roots is the same as in the Ligulifloræ. The root of the Radiatæ and Ligulifloræ is altogether destitute both of a laticiferous network and of isolated resiniferous cells, although possessing an endodermic oleiferous system.

In the Clusiaceæ the only regions in which secreting canals are not found are the pericycle, which forms in the stem a sclerenchymatous ring, and the primary or secondary xylem of the vascular bundles. The Hypericaceæ resemble the Clusiaceæ in the constant presence of secreting canals and in their general disposition, but differ from that order in their presence in the pericycle. The Ternstrœmiaceæ present in this respect a close resemblance to the Clusiaceæ. The Dipterocarpeæ differ, not only from these orders, but from all other angiosperms, in the presence of secreting canals in the xylem. In the complicated arrangement of the vascular bundles in the petiole they approach Malvaceæ.

Liquidambar and *Altingia* have their entire vegetative structure traversed by a system of oleiferous canals belonging to the primary liber in the roots, to the primary xylem in the stem and leaves. They may be said to combine the root of Anacardiaceæ with the stem and leaves of Dipterocarpeæ. The Simarubeæ have canals only in the stem and leaves, not in the root. The Dipterocarpeæ, Liquidambareæ, and Simarubeæ have this in common, that the stem and leaves have secreting canals localized in the primary xylem; they are distinguished from one another by the position of the canals in the root; in the Dipterocarpeæ these are in the primary xylem, in the Liquidambareæ in the primary liber; in the Simarubeæ there are none. In the only other order which has secreting canals in the xylem, the Coniferæ, they occur only in the root and stem.

Anatomical Structure of the Root.*—J. Constantin points out the great uniformity in the structure of the root as compared with that of the stem in the great divisions of the vegetable kingdom; but this he attributes to the much greater uniformity in the nature of the environment. In differing external circumstances he finds the structure of the root to vary in precisely the same directions as that of the stem.

When a root is fully exposed to the action of light, the thickness of the bark is less than in an underground root, while the central cylinder is, on the other hand, more developed. The endodermic punctations, so clear in underground roots, become indistinct in roots exposed to the light; all the fibrous tissues are more developed, both in the central cylinder and in the bark; and lignification has advanced considerably further.

* Bull. Soc. Bot. France, xxxi. (1884) pp. 25–8.

In roots entirely submerged in water, there is a well-developed intercellular system, while the vascular system is less developed. When an aquatic plant is transported on to dry land, the intercellular system diminishes, while the vessels become more numerous, and lignification is carried on further.

Growth of Roots.*—R. v. Wettstein thus states the laws which govern the growth of roots:—

1. In the first periods of development the growth is uniform; afterwards, from the period of germination, it is localized; the position of the zone of maximum growth varying. It begins at the collar, advancing gradually towards the apex, where it ceases.

2. The nearer the growing region approaches the apex of the root, the less rapidly does it advance.

3. The length of the growing region increases as it approaches the apex of the root, attains a maximum, and then decreases.

4. Neither the nature of the environment nor variations in temperature exercise any influence on the law of growth; even decapitation may not essentially alter the course of growth, at least at first.

5. As long as the region of most vigorous growth has not approached within about 4 mm. of the apex, the growth of the young root depends only on the elongation of the cells already formed in the seed. The first stage of growth is the result of this elongation taking place in fresh layers of cells, and the growing region thus advancing towards the apex.

6. When the zone of maximum growth has advanced to within 4 mm., or less, of the apex, cell-division and elongation of cells go on *pari passu*. In the second stage of growth the cells freshly formed near the apex contribute to the growth of the root by their elongation.

7. The first stage of the growth of roots is independent of the conduction of reserve-materials from the cotyledons or endosperm.

8. "Sachs's curvature" depends on a difference in the growth of the two sides of the root. This fact is in harmony with Wiesner's explanation of the occurrence of spontaneous phenomena of nutation in other organs.

Growth in length of decapitated and uninjured Roots.†—H. Molisch confirms Wiesner's statement that roots when deprived of their growing point grow less in length than uninjured roots under similar conditions of growth; and that this difference of growth in length depends greatly on temperature, being inconsiderable when the temperature is low. He further believes that the reasons why Kirchner has come to a different conclusion are probably that he worked at too low temperatures; that he removed too small a quantity from the apex of the root; and that the number of experiments performed was not large enough to arrive at definite conclusions.

* Anzeig. K. Akad. Wiss. Wien, Feb. 14, 1884. See Bot. Centralbl., xvii. (1884) p. 359.

† Ber. Deutsch. Bot. Gesell., i. (1883) pp. 362–6.

Geotropism and Hydrotropism of Roots.*—A. Tomaschek maintains that the degree of geotropism in a root does not depend on the rapidity of growth; nor is it affected even by severe injuries, provided the apex of the root is left uninjured. He regards the view of Darwin as fully established that the receptivity for the influence of gravitation resides in the apex of the root only, and moreover that the apex is susceptible to psychometric differences in the environment (hydrotropism), and that this susceptibility is conveyed to the adjacent parts.

Water-glands and Nectaries.†—W. Gardiner confirms Sachs's view that the exudation of water from water-glands is entirely due to root-pressure, and never takes place with cut organs; although in some cases (*Fuchsia globosa*) an abundant exudation from hairs in the vicinity of the water-glands gives the appearance as if it proceeded from the latter. Light retards very considerably the exudation of water both from water-glands and from those secreting epidermal structures which are not dependent on root-pressure. Water-glands are, as a rule, much more fully developed in Dicotyledons than in Monocotyledons, which may be due to the latter being of a more generally aquatic habit. The chief function, both of water-glands and of thin-walled epidermal cells placed in connection with a vascular bundle, is to allow of the escape of superfluous water, which would otherwise cause injection of the intercellular spaces, and even rupture of the tissue.

Nectaries, i. e. structures of whatever morphological value designed to secrete a saccharine fluid, do not, as Sachs has pointed out, discharge their nectar in consequence of root-pressure, but from the activity of the cells of the nectary themselves.

Folds of Cellulose in the Epidermis of Petals.‡—E. Köhne describes a number of different ways in which the lateral cell-walls of the epidermal cells of the petals are thickened and folded in a variety of plants. He discusses the purpose of these foldings, and believes it to be merely mechanical, in strengthening the epidermal layer of cells.

Anatomical Structure of Cork-woods.§—A. Gehmacher gives a detailed account of the anatomical structure of several extremely light woods from the tropics known as "cork-woods," viz. *Alstonia scholaris* from India, *Bombax Buonopozense* from Senegal, *B. Ceiba*, *B. pentandrum* from India, *Eriodendron anfractuosum* from India, *Kerminiera Elaphroxylon* from the White Nile, and the very beautiful Chinese "cork-wood," which comes apparently from the root of a Conifer. They all belong to the wood itself, and not to the bark.

"Filiform Apparatus" in Viscum album.‖—W. Scrobischewsky describes the "filiform apparatus" of the embryo-sac as very con-

* Oesterr. Bot. Zeitschr., xxxiv. (1884) pp. 55–9.
† Proc. Camb. Phil. Soc., v. (1884) pp. 35–50 (2 pls.).
‡ Ber. Deutsch. Bot. Gesell., ii. (1884) pp. 21–9 (1 pl.).
§ Oesterr. Bot. Zeitschr., xxxiv. (1884) pp. 149–55.
‖ SB. Vers. Rus. Naturf. u. Aerzte, Odessa, Aug. 24, 1883. See Bot. Centralbl., xviii. (1884) p. 156.

spicuous in the mistletoe. The division of the nucleus in the embryo-sac takes place in the ordinary way. At each end of the embryo-sac three cells are formed, three antipodals, two synergidæ, and an oosphere. The seventh nucleus lies within the protoplasm near the oosphere, and is remarkable for its size and its elongated form; this is the nucleus of the embryo-sac. At this period a small vesicle is formed in the wall of the embryo-sac in close proximity to the synergidæ, into which vesicle the two synergidæ project, destroying its wall at two spots; the cell-wall which is thus destroyed assumes a mucilaginous character, in the form of very slender threads, arranged in the form of a cone, and constituting the peculiar "filiform apparatus." The synergidæ then also begin to exercise a destructive effect on the outer part of the split wall of the embryo-sac; at two points, corresponding to the apices of the synergidæ, openings appear through which the pollen-tube can project free into the interior of the sac. By careful pressure the "filiform apparatus" can often be separated from the synergidæ. The threads of the latter coalesce, after fertilization, into long homogeneous semi-fluid masses.

The function of the synergidæ is therefore to facilitate the access of the pollen-tube to the oosphere (germinal vesicle) by absorption of the wall of the embryo-sac. All stages in the division of the nucleus can very easily be followed out in the formation of the endosperm of *Viscum album;* they agree with those described by Strasburger in the case of *Hyacinthus orientalis.*

Action of Heat upon Vegetation.*—A short note upon this subject by A. Barthélemy deals with (1) the action of heat upon the development and direction of growth of roots, (2) the action of heat upon the phenomena of heliotropism.

1. One experiment was made upon hyacinths growing in vessels of water; it was found that they invariably grew *towards* a heated brazier placed in their vicinity, whereas the leaves grew away from the source of heat and towards the window which was brightly illuminated. In another experiment a vessel of water was divided by a glass partition into two compartments, one of which contained hot water while in the other were placed hyacinth roots floating in cold water; the roots always grew towards the glass plate, and applied themselves closely to it. When the water was coloured by means of lampblack it was found that the growth of the roots towards the heated compartment was checked—possibly on account of the increased conductivity causing the temperature round the roots to become more uniform, or by the lessening of the diathermancy of the water which would hinder the action of the heat upon the roots.

2. The experiment made to show the action of heat upon heliotropism is described by the author as follows:—A pencil of solar rays was made to fall either directly or by a mirror upon a *Dipsacus* placed in a vase in a dark room; the stalk rapidly bent towards the

* Comptes Rendus, xcviii. (1884) pp. 1006–7.

source of light, but rapidly recovered as if by a rebound as soon as the light was removed and the roots of the plant watered.

Relation of Heat to the Sexes of Flowers.* — T. Meehan referring to his former communication † as to male flowers entering on active growth at a much lower temperature than the female, exhibited catkins and flowers of the European hazel (*Corylus avellana*), which, for the first time in several years, had perfected themselves contemporaneously. The past winter had been distinguished by a uniform low temperature the entire season. In other years a few warm days in winter would advance the male flowers so that they would mature weeks before the female flowers opened: hence the females were generally unfertilized, and there were few or no nuts. Under this law, it was evident, amentaceous plants could not abound to any great extent in countries or in localities favourable to bringing forward the male flowers before there was steady warmth enough to advance the female. He thought this was likely to be the reason why so many coniferous trees under culture in the vicinity of Philadelphia bore scarcely any fertile seed in their cones—a fact which had often been remarked in connection especially with the Norway spruce. The male flowers would mature before the female had advanced far enough to be receptive of the pollen.

Influence of Light on the Structure of the Leaves of Allium ursinum.‡—C. Musset has investigated the truth of the statement that light has an influence on the leaves of certain plants, and finds that, in *Allium ursinum*, at any rate, there is no change in structure which can be ascribed to the action of light.

Effect of Light and Shade on Pine-leaves.§—E. Mer describes at length the difference in the development of the "needles" of *Abies excelsa*, according to their position on the tree or the branch, and according to whether the tree stands alone or is closely surrounded by others, depending therefore on the amount and the direction of the light which falls on the leaves.

Movement of Water in Plants.‖—As a contribution towards our knowledge of the causes of the movement of water in plants, J. Dufour has made a series of observations of the relation between the size of the cell-cavity and the thickness of the cell-walls in a number of woody plants, with the following approximate results:—*Sambucus nigra*, cell-cavities (without vessels) 16–18·8 per cent., walls of wood-cells, 81·2–84 per cent.; *Fagus sylvatica*, diameter of vessels 7·4, cell-cavities 7·5, xylem-parenchyma 17·0, cell-walls 68·1 per cent.; *Hæmatoxylon campechianum*, cell-cavities 4·8–23·0, cell-walls 77–95·2 per cent.; *Cæsalpinia echinata*, cell-cavities 4·2–14·0, cell-walls 86–95·8 per cent.; *Alnus incana*, cell-cavities 43·5–

* Proc. Acad. Nat. Sci. Philad., 1884, pp. 116–7.
† See this Journal, iii. (1883) p. 532.
‡ Comptes Rendus, xcviii. (1884) pp. 1297–8.
§ Bull. Soc. Bot. France, xxx. (1883) pp. 40–50.
‖ Arbeit. Bot. Inst. Würzburg, iii. (1884) pp. 36–51 and Arch. Sci. Phys. et Nat., xi. (1884) p. 15. Cf. this Journal, *ante*, p. 414.

51·6, cell-walls 45·8–56·5 per cent.; *Buxus sempervirens*, cell-cavities of wood-cells 7·9, cavities of vessels 9·8, walls of vessels and cells 82·3 per cent.; *Morus alba*, cell-cavities (without vessels) 10·6–25; cell-walls 75–89·4 per cent.

The author retains his opinion that the cell-cavities and vessels of wood are in no way necessary for the transport of the sap. This movement takes place entirely in the cell-walls, in consequence of a little-known property belonging to their internal nature. It is, no doubt, to a certain extent influenced also by transpiration.

Movement of Water in the Wood.*—Both the prevalent theories with regard to the causes of the ascent of the sap in woody plants—that of imbibition, that it ascends through the porous walls of the vessels, while the cell-cavities are filled with air, and that of gas-pressure, that at the time of greatest transpiration the vessels are filled partly with sap, partly with bubbles of rarefied air—depend on the hypothesis that the cell-cavities or vessels of the wood contain air under normal conditions. M. Scheit throws grave doubts on the elementary fact on which both these theories are founded. The air-bubbles constantly found in the vessels in microscopical sections have probably entered in the process of dissection, and those said to have been observed in sections under oil are certainly in some cases bubbles of aqueous vapour. There are only two possible ways in which air can reach the tracheids, through the stomata or through the root. The first hypothesis is excluded by the fact that there is no direct connection between the stomata or the intercellular spaces and the vessels; the second is very improbable; it is difficult to understand how air could pass through the fluid which permeates the parenchyma and collect in bubbles. By a number of actual experiments on *Abies balsaminea* and *excelsa*, *Taxus baccata*, *Acer platanoides*, and *Pteris aquilina*, Scheit also determined the impermeability to air of moist wood and of the closing membrane of pits; the water-conducting organs contain nothing but water either in the liquid or gaseous state.

The author believes that the passage of water from the parenchyma into the tracheids is greatly facilitated by the bordered pits. The water is absorbed from the soil by the youngest parts of the roots and the root-hairs by means of osmose; the osmotic pressure is greatest at the thinnest spots of the cell-wall, the pits; and, as far as the elasticity of the closing membrane of the pits permits, this membrane is pressed in towards the cavity of the adjoining vessel, and brought into a position for filtration, so that water can now readily pass into the vessel. The manometer indicates that this root pressure may amount to as much as one atmosphere. The water thus pressed into the empty vessels rises through capillarity, and the root pressure has thenceforward nothing more to do than to place the closing membrane of the pits in a position for filtration; a continuous column of water being thus formed in the plant. The whole plant is permeated by a system of capillary tubes having its lower end in a tissue which absorbs water, the parenchyma of the root; its upper end in a

* Bot. Ztg., xlii. (1884) pp. 177–87, 193–202.

tissue which gives off water, the spongy parenchyma of the leaf; in the other parts of the plant this system is accompanied by the parenchyma of the wood and medullary rays, which latter convey to the cortex the water required by it; while in the stem the whole conducting apparatus is also enveloped by cambium.

Measurement of Transpiration.*—Under the name Potetometer J. W. Moll describes an instrument invented by him for the purpose of exactly measuring the quantity of water given off, in any space of time, by the foliage of plants.

Exhalation of Ozone by Flowering Plants.†—A series of experiments conducted by Dr. J. M. Anders go far to prove that flowering plants, especially odoriferous ones, give off ozone under the influence of sunshine. Schönbein papers suspended in glass cases with flowering plants showed under favourable conditions marked blue shades, and though Dr. Anders does not wish to say dogmatically that all the changes seen in the test-papers were produced by ozone, he considers it incontestable that this substance was the chief agent in their production.

With regard to the probable mode of its production, Dr. Anders concludes that "during the formation of the seeds there is a rapid metastasis of phosphorites, in the form of phosphoric acid, and the phosphates to that organ of the plant, and it may be reasonably supposed that in the chemico-vital changes going on in the ovules, phosphorus is liberated and acted upon by the moisture which the leaves and petals are so actively transpiring." Under these circumstances it not improbably follows that those flowers which produce the most seed are the largest generators of ozone, so that the sunflower may have other than æsthetic claims to our admiration.

Acids in the Cell-Sap.‡—G. Kraus has examined the relative proportion of acid in different plants, in different parts of the same plant, and in the same part at different times of the day. As a rule, in most woody and herbaceous plants, the leaves contain the largest, the root the smallest quantity of free acid, though there are exceptions to the rule. In the stem the acidity increases from above downwards, or, in other words, increases absolutely with age. He regards the acids as not mere products of excretion in metastasis, but as playing an important part in the processes of life. In geotropic curvatures the amount of free acid is both relatively and absolutely less on the convex side.

The formation of acid is, as a general rule, hindered by light. As regards periodicity, the maximum of free acid is found in the early morning; the amount then decreases steadily till the evening, when it reaches its minimum, increasing again gradually during the night.

* Arch. Néerl. Sci. Exact. et Nat., xviii. (1883) pp. 469–78 (1 pl.).

† Amer. Natural., xviii. (1884) pp. 337–44, 470–7. Cf. Engl. Mech., xxxix. (1884) pp. 313–4.

‡ Abh. Naturf. Gesell. Halle, xvi. (1884). See Bot. Centralbl., xviii. (1884) p. 100.

The most abundant acid in the sap is malic, occurring either free or as calcium malate; the amount of this salt appears to remain nearly constant by day and by night.

Kraus regards the vegetable acids as secondary products of respiration, occurring especially in those parts which contain abundance of protoplasm, the medium of respiration. He does not support the view that they are products of assimilation.

New Colouring Substance from Chlorophyll.*—R. Sachsse distinguishes two varieties of the derivative from chlorophyll previously described by him as phyllocyanin, but which he now prefers to call phæochlorophyll, viz.:—α phæochlorophyll, almost insoluble, and β phæochlorophyll, soluble with difficulty in alcohol. The latter substance is, when dry, nearly black, insoluble in water, soluble in alcohol, from which it separates on cooling in amorphous flakes, and in benzol. It is distinguished by its peculiar brown-yellow-green colour, and its formula is $C_{27}H_{33}N_3O_4$.

By heating β phæochlorophyll with baryta water or fusing with soda, it is deprived of carbonic acid, and a new substance obtained with the composition $C_{26}H_{33}N_3O_2$, which, when dry, is of a dark red-brown colour. Its solution in alcohol is dark red, which a few drops of sulphuric acid change to light red-violet. The colour itself and the spectrum are very similar to those of an alcoholic extract of violets. Saturation of an acid solution with alkali gives, however, a yellow or, in very concentrated solution, a red colour instead of green. Dry distillation with soda gives a crystalline sublimate soluble in alcohol and extremely soluble in ether.

Crystalline Chlorophyll.†—J. Borodin believes that he has obtained the long-desired result of pure chlorophyll in a crystalline form by slow evaporation of an alcoholic solution, though he has not as yet been able to isolate the crystals. They are doubly refractive, giving a beautiful green sheen in polarized light. Their physical properties differ from those of the dark-green crystals of hypochlorin hitherto obtained.

Crystals and Crystallites.‡—By the term crystallites A. Famintzin designates structures which agree neither with crystals nor with the organized products of living cells. They may be arranged under four different types, connected by transitional forms.

The mode of formation of crystals was illustrated by artificial crystals of potassium phosphate and magnesium sulphate. From these the author established the following points: (1) The original form of the crystal is not always its permanent form. (2) Crystals are formed constituting the half or even the fourth of a double rhombic pyramid. (3) Crystals do not always grow with flat surfaces,

* SB. Naturf. Gesell. Leipzig, x. (1883) pp. 97–101.

† SB. Vers. Russ. Naturf. u. Aerzte, Odessa, Aug. 25, 1883. See Bot. Centralbl., xviii. (1884) p. 188.

‡ SB. Vers. Russ. Naturf. u. Aerzte, Odessa, Aug. 24, 1883. See Bot. Centralbl., xviii. (1884) p. 158.

growth frequently taking place by means of irregular prominences. (4) Crystals exhibit a splitting both transverse and longitudinal.

Sphærocrystals.*—A. Hansen's extended paper on this subject is now published. A preliminary notice of it was given *ante*, p. 416.

Formation and Resorption of Cystoliths.†—Continuing his previous investigation of cystoliths, J. Chareyre has examined chiefly those of *Urtica Dodartii*, *U. pentandra*, *Cannabis sativa*, *Acanthus mollis*, *A. lusitanicus*, *Thunbergia alata*, and *Andrographis paniculata*, grown in different soils, in darkness and in light. He finds all the seeds of Urticaceæ examined before germination to contain reserves of food-materials composed entirely of aleurone-grains, in each of which is a globoid; and this is also the case with the seeds of Acanthaceæ, except those of *Acanthus* and of *Hexacentris coccinea*, which have no cystoliths, and in which the reserve food-material consists for the greater part of starch-grains. No portion of these reserves contributes to the formation of deposits of calcium carbonate, whether as cystoliths or in any other form. Nor are they employed in the formation of crystals of calcium oxalate, which do not occur in the plants under examination during or in the period following germination. When grown in pure silica the cystoliths do not attain full development; the pedicle is formed, but does not develope cellulose at its apex, and always dies away when entirely deprived of lime. Ordinary soil and soil formed of pure calcium carbonate are about equally favourable to the formation of cystoliths. When grown entirely in the dark, the seeds contain only rudimentary cystoliths in which is no calcium carbonate.

In reference to the influence of the death or etiolation of the leaf on the quantity of lime contained in the cystoliths, the author found that in the Acanthaceæ etiolation, and even death, has no effect on their formation. Among the Urticaceæ, and especially *Ficus elastica*, darkness causes, after from 10 to 15 days, complete disappearance of calcium carbonate in the cystoliths, this disappearance being connected chiefly with the cessation of the function of the chlorophyll. The carbonate is not converted into bicarbonate; and a disappearance takes place of calcium oxalate as well as carbonate. The lime has entered into combination with some other acid, which is probably pectic acid; it disappears from the leaves, and passes into the stem, at least partially, in the form of calcium pectate.

Development of Raphides.‡—A. Poli has investigated the formation of the raphides contained in the cellular tissue of the bulb of *Narcissus intermedius*, where they are always accompanied by a strong development of mucilage. They occur in longitudinal rows of cells, and in older examples are always imbedded in mucilage resulting from the deliquescence of the transverse walls, which mucilage escapes

* Arbeit. Bot. Inst. Würzburg, iii. (1884) pp. 92–122 (3 figs.).

† Bull. Soc. Bot. France, xxx. (1883) Sess. Extr., pp. viii.–xii. Cf. this Journal, iii. (1883) p. 389.

‡ Nuov. Giorn. Bot. Ital., xvi. (1884) pp. 56–9 (1 pl.).

from the plant in great quantities when wounded. In the young state only a single bundle of raphides is found in each cell, later they are much more numerous.

Here and there, in specimens preserved in alcohol, applied to the walls of the cells which contain the raphides were found solid spherical bodies of a yellowish colour and finely granular structure. The formation of these bodies was unquestionably due to the alcohol; and they probably arise from some gummy modification of the mucilage.

New Vegetable Pigment.*—A Rosoll finds in the involucral bracts of several species of *Helichrysum* a hitherto undescribed colouring substance, to which he gives the name helichrysin. It tinges the protoplasm, is soluble in water and alcohol, and is turned a purple-red by both acids and alkalies.

The same writer also describes methods for detecting saponine and strychnine in vegetable tissues. The first is easily recognized by the action of sulphuric acid, which it colours first yellow, then red, and finally reddish-violet. It occurs in the living cells dissolved in the cell-sap. Strychnine is coloured an intense violet-red by potassium bichromate and sulphuric acid. It occurs in all the cells of the endosperm of *Strychnos nux-vomica* and *S. potatorum* dissolved in a fatty oil.

Fish caught by Utricularia.†—G. E. Simms has discovered that newly hatched fish are caught and killed by the bladder-traps of *Utricularia vulgaris*. They are mostly caught by the head, which is pushed as far into the bladder as possible until the snout touches its hinder wall. The two dark black eyes of the fish then show out conspicuously through the wall of the bladder. By no means a few of the fish, however, are captured by the tail, and in several instances a fish had its head swallowed by one bladder-trap and its tail by another.

Prof. H. N. Moseley ‡ thinks it probable that the fact described by Darwin (that the larger of the two pairs of projections composing the quadrifid processes by which the bladders are lined project obliquely inwards and towards the posterior end of the bladder) has something to do with mechanism by which the fish become so deeply swallowed. The oblique processes, set all towards the hinder end of the bladder, look as if they must act, together with the spring-valves of the mouth of the bladder, in utilizing each fresh struggle of the captive for the purpose of pushing it further and further inwards.

* Anzeig. K. Akad. Wiss. Wien, 1884, Nos. 7, 9. See Bot. Centralbl., xviii. (1884) p. 94.

† Nature, xxx. (1884) pp. 81 and 295–6 (3 figs.).

‡ Ibid., p. 81.

B. CRYPTOGAMIA.

Cryptogamia Vascularia.

Anatomy of Vascular Cryptogams.* — P. Van Tieghem has studied several points in the anatomy of vascular cryptogams, recent and extinct. The secondary tissues of cryptogams, like those of phanerogams, proceed normally from two concentric generating layers; an external one in the cortex, forming bark outwardly, and secondary cortex inwardly; an inner one in the central cylinder, intercalated in the liber and in the xylem of the primary vascular bundles, producing secondary liber outwardly, and secondary wood inwardly. The normal subero-cortical generating layer is well developed in the stem (*Botrychium*, *Helminthostachys*), root (*Botrychium*, *Helminthostachys*, *Angiopteris*, *Marattia*), and leaves (*Botrychium*, *Angiopteris*, *Marattia*). The normal libero-ligneous generating layer is developed both in living ferns (*Botrychium*, &c.) and in extinct vascular cryptogams, as *Sphenophyllum* and *Sigillaria*. In addition to these normal layers we find in certain species two other abnormal generating layers: one external to the primary vascular bundles (*Isoetes*), and one interior to the primary vascular bundles (*Botrychium*).

The author also describes several anomalies in the primary structure of the root, viz. in the principal trunk and in the branches of a dichotomous root.

Fertilization of Azolla.†—E. Roze has studied the structure of the androspores (microspores) and gynospores (macrospores) and the mode in which fertilization is effected in *Azolla filiculoides*, but without adding anything fresh of importance to what is already known. He observes that the barbed hairs attached to the "massulæ" as they escape from the androsporangium do not occur throughout the whole genus, being wanting in *Azolla pinnata* and *nilotica*. The internal membrane of the gynosporangium, which remains attached to the gynospore in the form of a funnel, appears to play an important part in fertilization in facilitating the access of the antherozoids.

Muscineæ.

Male Inflorescence of Mosses.‡—H. Satter confirms the observations of Leitgeb and Kühn in the case of *Fontinalis* and *Andreæa*, that the axil of the shoot is used up in the formation of the antheridial receptacle, Leitgeb regarding this to be the rule with mosses. The author shows that this is also the case with many Bryineæ, also with *Phascum* and *Archidium*, which display apparent exceptions to the rule.

In *Phascum cuspidatum* the last three segments and the apical cell

* Bull. Soc. Bot. France, xxx. (1883) pp. 169–80.
† Ibid., pp. 198–206 (1 fig.).
‡ Ber. Deutsch. Bot. Gesell., ii. (1884) pp. 13–9 (1 pl.).

form antheridia; behind the three leaves which are formed earlier lateral shoots arise, or more often behind the youngest of them only, and always behind the cathodal half of the leaf-forming segment. After the formation of usually only three whorls of leaves, these pass over to the formation of archegonia. In the leaves behind which the shoots arise the formation of a midrib is suppressed, and they are subject also to a variety of displacements in their insertion. The first of the archegonia is formed out of the apical cell, the three or four others out of the youngest segments. When the sexual organs are mature, the female branch projects only slightly above the male inflorescence; it is only after impregnation that any considerable elongation takes place, by which the male inflorescence is pushed to one side, or comes to stand in the fork, and is then surrounded by two involucral leaves.

The process is the same in *Archidium phascoides*, only that there is no considerable elongation of the female shoot; and hence the archegonia and antheridia are apparently inclosed in a common perichætium composed of involucral leaves.

The same relative position of the sexual organs is exhibited by *Pottia subsessilis*, *P. cavifolia*, *P. truncata*, *P. minutula*, *P. Heimii*, *Distichium inclinatum*, *Desmatodon obliquus*, *D. Laureri*, and *Oreas Martiana*. There is in these cases no doubt that the antheridial receptacle is the termination of the main axis, and that is pushed aside and overgrown by the elongation of the female branch.

A modification of this arrangement is exhibited by many species, as *Orthotrichum crispulum*, *O. Hutchinsiæ*, *Bartramia Halleriana*, *B. pomiformis*, *Amblyodon dealbatus*, &c., where the lateral shoots do not arise immediately beneath the male inflorescence, but in lower whorls of the male shoot. Either these lateral shoots form archegonia at once, or antheridia are again formed through several generations of shoots, archegonia only in a later generation. In *Amblyodon* these last branches are not always exclusively female, but have often sexual organs of both kinds united in the same inflorescence. The author considers that such a hermaphrodite inflorescence consists of two independent shoots, the female one being formed immediately beneath the antheridium-bearing segments, without producing any vegetative segments, proceeding directly to the formation of archegonia; this view being confirmed by transitional forms.

Lesquereux and James's Mosses of North America.*—This book includes all the mosses which are known on the North American continent within the limits of the United States and northwards. 900 species are dealt with, a very large portion of them being European. The classification does not differ materially from that of Bruch and Schimper (used in Wilson's 'Bryologia'). The definitions of species and genera are commendably full and clear, and the authors have avoided establishing or admitting species upon a slender foundation of differential character.

* Lesquereux, L., and T. James, 'Manual of the Mosses of North America,' 447 pp. and 6 pls. 8vo, Boston, 1884.

Fungi.

Supposed Absorption and Disengagement of Nitrogen by Fungi.* —G. Bonnier and L. Mangin detail a series of experiments by which they claim to have proved that the statement that fungi both absorb and give off nitrogen while in a state of vegetative activity is founded on error. The process of respiration consists solely in a disengagement of carbon dioxide.

Fungus parasitic on Drosophila.†—The Rev. J. L. Zabriskie describes *Appendicularia entomophila* Peck, a new fungus parasitic on the fly *Drosophila nigricornis* Loew. It is closely related to the Sphæronemei of the Coniomycetes. Like *Sphæronema*, the fruit has a bulbous conceptacle, surmounted by a long beak perforated at the apex, where the spores ooze out in a globule; but, unlike any described *Sphæronema*, this has the conceptacle seated upon the broad summit of a pedicle as long as the conceptacle itself; and also on one side of the summit of the pedicle and at the base of the conceptacle, it has an erect, leaf-like appendage, with strongly serrate margins, like a white-elm leaf folded along its midrib. The pores are slender, pointed at each end, and divided by a septum into two unequal cells, one cell being twice as long as the other. The total length of the fruit is from ·02 to ·03 in., and that of the spores from ·001 to ·002 in. The conceptacles of the fungus project directly from different points of the surface of the fly; so that they are found in all positions—erect, horizontal, and dependent. They grow sometimes singly, but oftener in clusters of two, three, or more, and are found most frequently on the tibiæ of the hind legs, but also springing from the inner posterior surfaces of the abdominal rings, from the costal vein of the wing, from the head, and from the thorax. One fly had about fifty of these conceptacles on various parts of the body and limbs.

Peronosporeæ.‡—M. Cornu gives (1) a monograph of the parasite of the lettuce, *Peronospora gangliiformis*, (2) an important memoir on the *Peronospora* of the vine. In both memoirs the best modes of treatment are discussed for checking or warding off the disease.

Vine-mildew.§—E. Prillieux has observed on *Peronospora viticola* reproductive bodies of a peculiar kind which he regards as probably intermediate between the ordinary conidia and oogonia. They appear in the same position as the conidia, emerging from the stomata of the leaf, and consist of short filaments terminating in pear-shaped bodies considerably larger than the ordinary conidia and separated from the pedicel by a septum. Their germination has not been observed.

The author is of opinion that the ordinary "rot" or "grey rot" of the American vines is produced by *Peronospora viticola*, and not by

* Bull. Soc. Bot. France, xxxi. (1884) pp. 19–22.

† Science, iv. (1884) p. 25.

‡ Cornu, M., 'Observations sur le Phylloxera et sur les parasitaires de la vigne.' See Bull. Soc. Bot. France, xxx. (1883) pp. 36–8.

§ Bull. Soc. Bot. France, xxx. (1883) pp. 19–24, 228–9.

Phoma uvicola, as had previously been supposed; although the latter fungus undoubtedly makes its appearance in the berries or seeds which have already been attacked by the *Peronospora*, but it plays only a secondary part.

The germination of the oospores of *P. viticola* has further been observed by Prillieux. On germinating the oospore gives rise to a branching tube which bears a number of conidia.

New Theory of Fermentation.*—E. Cocardas propounds the strange theory that all the different kinds of fermentation—which are as numerous as the different kinds of protoplasm—are due to the action of a single organism, *Penicillium*, which appears, according to its vital conditions, in the various forms of *Bacterium*, *Bacillus*, *Spirillum*, *Zoogloea*, *Hygrocrocis*, *Leptomitus*, *Torula*, *Byssus*, *Mucor*, *Aspergillus*, *Penicillium*, *Micrococcus*, *Microderma*, *Saccharomyces*, &c.

Microbes in Human Saliva.†—A. F. Rasmussen has made a careful examination of the micro-organisms found in the saliva of healthy men, with the following results.

The sources of these microbes—mould spores, ferment-fungi, and bacteria—are the air and the food; some disappear immediately, while others remain and undergo further development. The temperature of the mouth, 36°–37° C., is very favourable for their development, nutrient substances and oxygen being also always present in great abundance. The organisms are especially abundant at the outer side of the base of the back teeth, especially in the upper jaw, where a thick layer of tough mucilage is always found in the morning, and for some time after a meal. Carious teeth also breed large quantities of these organisms.

The author found none of the methods previously used for the culture of these organisms satisfactory; culture on a solid substratum he always found the most advantageous. The gelatine used for the purpose was placed in bulbs with a large bottom, so as to give as large a surface as possible. The staining employed was sometimes Koch's method, sometimes potassium biniodide, which however caused great changes in the size of the objects. Thus the sporiferous segments of *Clostridium polymyxa* measured 4–6 μ before, 2·2 to 2·4 μ after staining. The reagent for *Leptothrix* employed was potassium biniodide with a small quantity of hydrochloric acid.

The bulbs and test-tubes used were purified by concentrated sulphuric acid and distilled water, or with dilute (0·1 per cent.) solution of corrosive sublimate; and the wad-plugs used to close the apparatus were sterilized by a temperature of 110–120° C. For culture in nutrient fluids the author used the bulbs recommended by Salomonsen; various fluids were used, as human urine diluted with water and boiled for ten minutes, then filtered and neutralized with sodium carbonate, bouillon, solution of peptone, beer-wort, solution of

* Bull. Soc. Bot. France, xxxi. (1884) pp. 12–8.

† Rasmussen, A. F., 'Om Dyrkning af Mikroorganismen fra Spyt af sunde Menesker' (Danish) 136 pp. (2 pls.). See Bot. Centralbl., xvii. (1884) p. 389.

potassium albuminate, prepared by Lieberkühn's method, &c. For conveying bacteria from one vessel to another, finely drawn-out glass capillaries were used, first sterilized in a flame.

The author describes the culture of the microbes on potatoes, turnips, and on rye-bread; and rules are given for the preparation of the nutrient substance, the method of Koch and Brefeld being essentially followed. After a longer or shorter time small patches, dots, elevations, cushions, and similar structures arise, due to the microbes propagated from the saliva. These may be either (1) white moist opaque elevations—micrococci and bacteria, or (2) grey, dry, somewhat transparent patches—bacilli, colonies of a leptothrix-ferment, or oblong cells; torula and round saccharomyces-cells constitute a transition between the two; *Penicillium glaucum*, *Oidium lactis*, and a few species of *Mucor* were also met with, but the colonies of these forms are very easily confounded with those named before.

Culture on nutrient gelatine closely resembles that on potatoes; but many of the cultivated organisms deliquesce on the surface of gelatine; this is the case with the chromogenous bacteria, the sporiferous bacilli, *Penicillium*, and *Cladosporium*. In the gelatine-culture other phenomena also present themselves. Some forms grow downwards towards the bottom of the vessel, and form wedge-shaped figures; torula puts out lateral branches from these wedges; other forms spread out horizontally over the bottom; *Micrococcus luteus* forms delicate pellicles, from which threads branch vertically downwards; *Bacillus Ulna* forms a kind of diffuse infiltration, which descends into the gelatine and decomposes it on the surface. Culture upon gelatinized serum presented no very distinct peculiarities.

As regards the systematic position of the microbes observed, the author speaks first of the Zygomycetes, *Mucor racemosus* and *stolonifer;* also *M. spinosus*, new to Denmark, but observed only once. In all cases they had the faculty of forming torula-cells. Among Ascomycetes, *Penicillium glaucum* and *album* were observed, and among Hyphomycetes, *Cladosporium herbarum*, and *Oidium lactis*, the latter being one of the most frequent of the saliva-organisms. *Torula* was also found abundantly in nutrient fluids, and on gelatine and potato; when transferred to solutions of grape-sugar or to diluted urine, it exhibited no power of fermentation or of inverting. Under the name "torulose cells" (*hefeähnliche Zellen*) the author describes colourless or reddish cells, either roundish or elongated, and also peculiar species of *Saccharomyces*, which are only stages of development of higher fungi. One of these flesh-coloured species appears to be allied to Cohn's *Saccharomyces glutinis;* a second unnamed form was 9–11 μ long, 4 μ broad, with drops of oil imbedded in the protoplasm; a third consisted of round and elongated cells arranged in colonies, 11 μ long, and 3 μ broad, with no drops of oil. *Saccharomyces apiculatus* was not observed.

With regard to the Schizomycetes, the author considers that the view of Zopf that the different forms are stages of development of the same organism is true only of *Leptothrix*, which may go through all the various forms, while all the other Schizomycetes have one form

only. Of these constant forms he finds *Bacillus Ulna*, *Clostridium butyricum*, *C. polymyxa*, and several others not named, but no constant bacterium, and only once a coccus.

Of *Leptothrix* three distinct forms are described in detail, one of them chromogenous. Two of these he regards as comprised under *L. buccalis*, which together with spirillum, vibrio, and *Spirochæte denticola*, causes the mucilage of the teeth.

Of other chromogenous forms the author finds *Micrococcus luteus*, two unnamed, and *Bacillus Hansenii*, a new species. Cultivated on potato, this form grows with extraordinary rapidity, almost to the exclusion of all others.

Experiments are described which lead to the conclusion that the fluid in some cases contains micro-organisms when it enters the mouth from the ductus stenonianus; but that the air expired from the lungs is free from them.

Microbia of Milk.*—F. Hüppe has made a detailed examination of the microbia of milk, which can, he states, be completely sterilized by a temperature of 75°–100° C. He describes in detail the bacteria connected with the fermentation of milk, their biological relationships, and their chemical action on the milk. The bacilli of butyric fermentation are also described, the organisms of blue milk, other pigment-forming bacteria, mucilaginous milk, and *Oidium lactis*. The author holds very strongly the view of the constancy of the bacteria of milk.

Microbe of "Morbillo."†—M. Lanzi has investigated the microbe characteristic of this infection which he finds especially in the desquamated scales of the skin and in the urine. He considers it to be a species peculiar to this complaint, to which he gives the name *Bacterium morbilli* with the following characters:—Cells round or elongated, colourless, motile, isolated or united into chains of various lengths, composed of two or more cells, straight or more often curved, and even spiral: cells, 0·8–1·0 μ in diameter, with the length varying from this to double as much; no zoogloea-form was observed; propagation by fission in one direction, and then forming spores. Occasionally a large bacillus-form was assumed. The best staining reagent was found to be methyl-violet. *Bacterium morbilli* has no power of causing fermentation in the urine like *Micrococcus ureæ*. Without considering the question decided, the author leans to the opinion that it is the cause, and not merely the accompaniment of the disease.

Bacillus of Cholera.‡—T. R. Lewis denies the validity of Dr. Koch's conclusions as to the "comma-shaped" bacillus being the cause of cholera, as bacilli identical in size, form, and in their reaction with anilin dyes with those found in choleraic dejecta are ordinarily present in the mouth of perfectly healthy persons.

* MT. K. Gesundheitsamtes, v. p. 309. See Naturforscher, xvii. (1884) p. 251.

† Bull. Accad. Med. Roma, ix. (1883) No. 7.

‡ Nature, xxx. (1884) pp. 513–5.

Rabies.—The Government committee appointed to inquire into the experiments of M. Pasteur, report that his statements have been entirely borne out. Inoculation with the attenuated virus of hydrophobia gives a dog immunity from the disease, just as similar treatment preserves a sheep from charbon. All the 23 dogs submitted by M. Pasteur as having been thus inoculated have resisted the strongest virus on inoculation, whereas the majority of the 19 non-inoculated dogs have succumbed. Of the latter, six were bitten by mad dogs, three of them becoming mad, eight were subjected to intravenous inoculation, all becoming mad, and five to inoculation by trepanning, all becoming mad. The result is decisive; but the committee will now inoculate a large number of fresh dogs, and will compare these with an equal number of dogs not inoculated. It will likewise investigate the question whether, after a dog has been bitten, inoculation with the attenuated virus will prevent any consequences from the bite.

Etiology of Tuberculosis.*—Dr. G. N. Sternberg has repeated Koch's inoculation experiments, and is able to confirm him as to the infectious nature of tuberculosis; also as to the presence of the bacillus discovered by him, in tubercle nodules in the lungs and in tuberculous glands of inoculated rabbits and guinea-pigs (inoculated with sputum containing the bacillus from a phthisical patient). The experiments of Formad of Philadelphia, by which he claims to induce tuberculosis in rabbits as a result of the introduction into the cavity of the abdomen of finely powdered inorganic material, have also been repeated, with an entirely negative result so far as the production of tuberculosis is concerned.

The conclusion is therefore reached that the bacillus of Koch is an essential feature in the etiology of the infectious disease, tuberculosis.

Bacteria and Minute Algæ on Paper Money.†—J. Schaarschmidt, in consequence of Prof. Reinsch's discovery ‡ of bacteria and algæ on coins, has examined Hungarian bank and State notes and Russian one-rouble notes, and finds schizomycetes and algæ on all of them even upon the cleanest.

The vegetation of paper money is, as the result of his researches, composed of the following: *Micrococcus*, *Bacillus*, *Leptothrix* (various forms), *Bacterium termo*, and *Saccharomyces cerevisiæ*. Also, very rarely, Reinsch's *Chroococcus monetarum* and *Pleurococcus monetarum*.

Grove's 'Synopsis of the Bacteria and Yeast Fungi.' §—This book reaches us too late to say more than that it is a very handy and well-arranged synopsis of the Schizomycetes and Saccharomycetes, which cannot fail to be of invaluable assistance to microscopists

* Abstract of paper read before Section F (Biology) of the Amer. Assoc. Adv. Sci., Philadelphia, Sept. 9, 1884.

† Nature, xxx. (1884) p. 360.

‡ See this Journal, *ante*, p. 428.

§ Grove, W. B., 'A Synopsis of the Bacteria and Yeast Fungi and allied species.' 8vo, London, 1884. vi. and 112 pp. (87 figs.).

interested in its subject, and not the less so that our knowledge regarding these organisms is at the present time in so scattered and undigested a condition.

Protochytrium Spirogyræ, a new Myxomycete (?).*—A. Borzì describes a parasitic organism of very low organization, which he finds in the cells of *Spirogyra crassa* and of a few other nearly allied species of algæ, rapidly destroying the contents of the cells and causing complete disintegration of the filaments, the cell-walls themselves ultimately entirely perishing. The minute masses of protoplasm of which it is composed are completely destitute of cell-wall, and display amœboid motions, but without any pseudopodia. They derive their nutriment directly from the surrounding protoplasm, and may be regarded as plasmodia of very reduced dimensions. They are composed of homogeneous protoplasm, within which are very fine granulations, and have, therefore, all the characters of an organization the simplest that can be imagined. They compose a true *jaloplasm* in the sense of modern histologists, constantly altering its form in consequence of its amœboid motions. The granulations are frequently disposed round a small transparent central areole, which represents a true vacuole. It is, however, entirely destitute of true nuclei, the minute granulations wanting all the characteristic structure of these organisms. The central vacuole is constantly altering its position, and alternately contracting and expanding. The principal, if not the sole, agent in these amœboid movements appears to be the superficial protoplasmic layer. The growth of these organisms is rapid, and they attain a diameter of about 40 μ in twelve hours.

The process of nutrition may be divided over two distinct periods. In the first the nutriment, derived from the surrounding substratum, passes directly into the body of the parasite. In the second period, the substances, already ingested and deposited, become somewhat elaborated and digested. These two phases can be well followed under the Microscope.

When one of the plasmodia comes into contact with a band of chlorophyll, it slowly penetrates into its interior. A small portion of the nutrient substance, consisting of protoplasm containing chlorophyll and of starch-grains, becomes at length entirely imprisoned in the mass of the plasmodium. The ingested substance retains for a very short time its original properties. The chlorophyll soon loses its green colour; the granules of starch are the last portion to be completely absorbed. An excretory portion which is not digested is finally expelled.

The vegetative activity of the plasmodia ceases on the commencement of the reproductive period; they attain a state of quiescence, and the formation of zoosporangia commenecs. The peripheral layer of protoplasm becomes thinner and tends to merge in the internal portion; its motility at the same time disappearing altogether. After numerous internal changes in the structure of the protoplasm, the contents divide by successive bipartitions, either a

* Nuov. Giorn. Bot. Ital., xvi. (1884) pp. 5-32 (1 pl.).

portion or the whole of the protoplasm being used up in the formation of zoospores, which process is a very rapid one. On escaping from the zoosporangium these bodies are minute pear-shaped or ovoid masses of protoplasm, containing granulations, and not invested with a cell-wall, provided at one end with a flagelliform cilium, and also with a contractile vacuole. In some cases the zoospores are unable to escape from their parent cell, and transform themselves directly into new zoosporangia. Either the ordinary zoospores or those derived from these secondary zoosporangia, after moving about actively for half an hour, lose their cilium, and become transformed into an ordinary amœboid mass of protoplasm, with movements due to contractions and dilations, in which condition they may be described as *myxamœbæ*. In this state they not unfrequently come together and coalesce, the two vacuoles remaining for a time distinct, but finally uniting. The original plasmodia are formed either from a single myxamœba, or result from a fusion of several; and these may then propagate themselves for several generations before the formation of zoospores.

Instead of the production of zoospores, the period of vegetative activity of *Protochytrium* is frequently closed by the formation of *cysts*, or true encysted plasmodia, especially at the period when the host naturally dies. These are cells with double walls, and with a considerable space between the outer and inner walls; this space is filled with a transparent fluid, often containing small remains of nutrient substance not completely digested. The ordinary diameter of the cyst itself is from 15 to 25 μ, that of the external envelope from 30 to 40 μ. This external envelope displays many of the properties of fungus cellulose. The internal contents consist of a dense finely granular protoplasm. These cysts are formed within the cells of the host, and when they decay, fall to the bottom of the water, where they germinate after a period of rest, and develope into myxamœbæ. These again enter the cells of the host by penetrating through the cell-walls, in the same manner as the germs of many Chytridiaceæ.

As regards its systematic position, *Protochytrium* displays on the one hand affinities with the Myxomycetes, and on the other hand with such genera of Chytridiaceæ as *Woronina*, *Rozella*, and *Olpidiopsis*; but the author considers the entire absence of a cell-nucleus to be a point of so great morphological importance that it must for the present be referred to Klein's family of Hydromyxaceæ, along with the forms of *Monas* described by Cienkowski and Häckel, and also *Vampyrella*, *Monadopsis*, and *Protomyxa*.

Lichenes.

Substratum of Lichens.*—O. J. Richard, besides combatting the theory of an algo-lichenic association, holds that the nature of the substratum, whether calcareous, siliceous, metallic, organic, or neutral,

* Actes Soc. Linn. Bordeaux, 88 pp. See Bull. Soc. Bot. France, xxx. (1883) Rev. Bibl., pp. 105-7.

is of small consequence to the lichen, which derives no nutriment, but merely support therefrom. Nor does the author agree that the chemical composition of the thallus varies according to the nature of the substrata.

Hymenolichenes.*—This section of lichens was established by Mattirolo † from the genus *Cora*, and depends on the symbiosis of an alga with a fungus belonging to the class of Hymenomycetes. F. Johow has critically examined the group in its native country of Venezuela and the West Indies, and includes in it the four following genera:—*Cora*, *Rhipidonema*, *Dictyonema*, and *Laudatea* gen. nov. The first three genera must be regarded, from their habit and the lamination of their thallus, as heteromerous foliaceous lichens, but differing from all other genera in the entire absence of a solid cortex and in the unusually complete investment of the algæ which perform the function of gonidia. *Laudatea* is distinguished by its peculiar cæspitose habit, and by the segmentation of the thallus connected with it into a saprophytic mycelium and green stems composed of bundles of gonidia invested by fungus-hyphæ.

The systematic position of the Hymenolichenes is among the Thelephorea, and in near relationship to *Thelephora*, *Corticium*, and *Hypochnus*. The only organs of reproduction which they possess are sporiferous basidia growing on the under side of unilateral pilei, or on crustaceous receptacles (*Laudatea*). Nylander's statement of the presence in *Cora* of apothecia has not been confirmed. The saprophytic mycelium and crustaceous receptacle of *Laudatea* find their analogue in numerous species of *Thelephora* and *Corticium*. The green foliaceous thallus of *Cora* is homologous to the receptacle of *Thelephora*.

Algæ.

Fresh-water Phæospore.‡—Under the name *Lithoderma fontanum*, E. Flahault describes a fresh-water phæosporous alga from the neighbourhood of Montpellier. It agrees with other species of the genus in having the zoosporangia naked and superficial. The thallus is closely adherent to the substratum, recalling that of *Melobesia* or *Coleochæte*. The zoospores are ovoid, unequilateral, with a red eye-spot and two unequal cilia inserted on the concave side of the zoospore, and directed one forwards, the other backwards. They germinate directly, without conjugation.

Nostoc.§—C. Flahault has had the opportunity of examining the structure of the rare *Nostoc flagelliforme*, growing in the neighbourhood of Montpellier, described by Berkeley and hitherto known only from Texas. He regards it as identical with the *Nematonostoc rhizomorphoides* of Nylander, which genus must therefore disappear. Spores were not observed, but hormogonia frequently. *Nostoc flagelli-*

* SB. K. Preuss. Akad. Wiss. Berlin, 1884 pp. 113–28; also Pringsheim's Jahrb. f. Wiss. Bot., xv. (1884) pp. 361–409 (5 pls.).

† See this Journal, ii. (1882) p. 542.

‡ Comptes Rendus, xcviii. (1884) pp. 1389–91.

§ Bull. Soc. Bot. France, xxx. (1883) pp. 89–96 (1 pl.).

forme must also disappear as a species, being merely a variety of *N. ciniflorum* Vauch.

Flahault further identifies *Nostoc coriaceum* Vauch. as a form of *N. ciniflorum*.

New Chromophyton.*—M. Cornu describes an alga coloured by a yellow pigment found in a spring of fresh water, in company with *Navicula*, and possessing a siliceous coat similar to that of diatoms. He regards it as nearly allied to Woronin's *Chromophyton Rosanoffii*,† differing from that species in its siliceous envelope, and in the possession of stalked bodies which may be sporangia. He proposes for it the provisional name *Chromophyton Woronini*.

Wolle's Desmids of the United States.‡—The Rev. F. Wolle's work on the desmids of the United States will be found useful by English cryptogamists who are not in possession of Ralfs' work. Eleven hundred coloured figures are given illustrating all the species and varieties described in the text.

New Diatoms.—Diatoms from Stomachs of Japanese Oysters.§—F. Kitton describes some new diatoms taken by Mr. G. Sturt from the stomachs of some "tinned" oysters from Japan, sent to the Fisheries Exhibition, viz., *Aulacodiscus Sturtii* and *Amphipleura pellucida* var. *rectus*. Nearly 90 other marine species as well as a considerable number of fresh-water species from the stomachs were identified by Mr. E. Grove.

Mr. Sturt's directions for examining the stomachs of oysters, &c., are as follows:—"After opening the tin and pouring off the liquid contents, I empty out the oysters and pick out the stomachs (which look like dark little sacs, and as a rule are free, or only partially surrounded by a little fatty matter, which is easily taken off). I then heat in a glass to boiling point five or six ounces of nitric acid, in which I drop one by one the stomachs, waiting until each is dissolved before adding another. After all have been dissolved I add an ounce of hydrochloric acid, and continue the boiling for five minutes, dropping in at intervals a little bichromate of potash. I now fill up the flask with hot water and empty the whole into a large beaker, filling up with the hot water (the fat rises to the surface, and on cooling congeals on the top, and is easily skimmed off). I wash away the acid, using hot water, and boil in soap and water according to Prof. H. L. Smith's directions. If this does not get rid of the organic matter, I boil in sulphuric acid and chlorate of potash." The water used for washing must be filtered rain or distilled water and free from all trace of acid.

Mr. Kitton also describes, from other localities, the following new species:—*Surirella carinata* and *Sceptroneis* (?) *clavus*.

* Bull. Soc. Bot. France, xxx. (1883) Sess. Extr., pp. xciii.–v.

† See this Journal, i. (1881) p. 100; iii. (1883) p. 108 and 863.

‡ Wolle, F., 'Desmids of the United States and list of Pediastrums.' 168 pp. and 53 pls. 8vo, Bethlehem, Pa., 1884.

§ Journ. Quek. Micr. Club, ii. (1884) pp. 16-23 (1 pl.).

Structure of Diatoms.*—According to L. Reinhardt a form of valve similar to that described by Müller in *Triceratium*, occurs in many, if not all forms with areolated cell-wall.

The formation of the pedicel and of gelatinous colonies are phenomena altogether analogous to those which occur in the palmelloid algæ. In the *Mastoglœa* colonies it is easy, when the formation of jelly has not advanced beyond a certain extent, to observe a similar system of intercalation of cell-walls as in *Glœocystis*. In the cell-wall of *Mastoglœa* and other similar forms, two layers can be distinguished, an outer gelatinous, and an inner layer which retains its consistency and structure. In the formation of the pedicel the outer layer becomes locally mucilaginous. In those forms where an entire group of individuals is attached to a single pedicel (as many species of *Synedra* and *Licmophora*) longitudinal striæ make their appearance on the thick pedicel corresponding to the separate cells; these are made distinctly visible by staining with hæmatoxylin.

The author also describes the formation of auxospores in *Cocconeis communis*, *Achnanthes longipes*, and *A. brevipes;* in the first species their development was followed out in several hundred specimens. The auxospores are always formed by the conjugation of two individuals, never by rejuvenescence, as stated by Schmitz. The conjugating cells often open at different times, and the formation of the mucilaginous bladders begins only with the coalescence of the conjugating masses of protoplasm. The nuclei of the conjugating cells move slowly in the direction of the movement of the protoplasm towards the anterior margin of the masses of protoplasm, and, a short time after these commence to coalesce, a single much larger nucleus is seen in the place of the two. Conjugation of the nuclei therefore takes place here. The author further describes the formation of the perizone and of the cell-wall of the auxospore, the growth and bipartition of the chromatophores, and the division of the auxospores into two primary cells. In *Achnanthes longipes* the conjugation always takes place in a very interesting way between two cells which are not equivalent. One of these has always a long pedicel, whilst the other is attached by a gelatinous disk to the upper end of the pedicel of the first. When the protoplasmic masses of two cells coalesce, a mucilaginous bladder is formed, which is connected only with the lower valve of the stalked cell. Since this bladder is formed essentially from the protoplasm of the stalked cell, it follows that that of the other cell passes into the bladder of the first. The phenomena in this species justify the regarding of the formation of auxospores by conjugation as a process of sexual reproduction. In *A. brevipes* the process is the same in its general features. The formation of auxospores without conjugation is regarded by the author as a kind of apogamy.

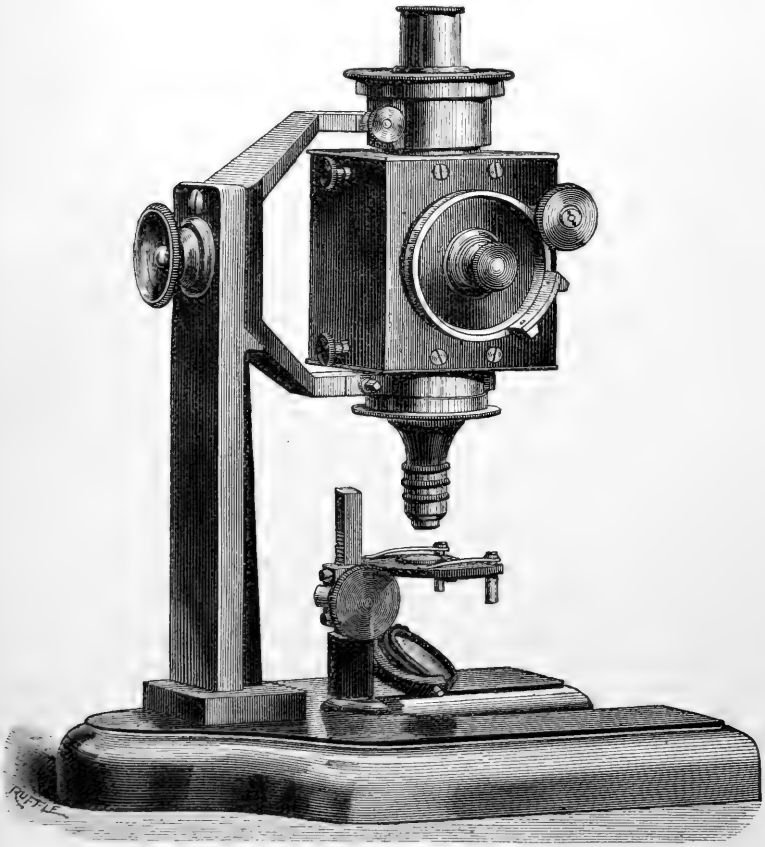
* SB. Vers. Russ. Naturf. u. Aerzte, Odessa, Aug. 27, 1883. See Bot. Centralbl., xviii. (1884) p. 191.

MICROSCOPY.

a. Instruments, Accessories, &c.

Albertotti's Micrometer Microscope.*—Dr. G. Albertotti, jun., has designed the instrument shown in fig. 123, for the purpose of measuring microscopic objects more satisfactorily than can be done with either eye-piece or stage micrometer.

Fig. 123.



If the diverging plates of Helmholtz's ophthalmometer are interposed between the eye-piece and objective of a compound Microscope in such a way that the axis of the plates is at right angles to the axis of the Microscope, the effect of the plates on the apparent

* Ann. di Ottalmologia, xi. (1882) pp. 29–30 (1 pl.).

position of an object seen through the Microscope will be the same as when they are used without a Microscope, i. e. so long as the plates are in one plane the image is unchanged in its position, but as soon as the plates cross at an angle it will be separated into two images of equal size, which are displaced in opposite directions. By turning the plates through a sufficient angle the displacement can be so arranged that the margins of the two images which are turned to each other shall coincide, and a compound image is formed which, in the direction of the displacement is twice as large as the original one. For the same eye objective and eye-piece and for a constant distance of both from the axis of the plates, the angle of inclination to be given to the plates, in order to double the image, bears a fixed relation to the size of the object and may therefore be used to measure it.

If a table is prepared showing the values in mm. of the angles of inclination of the plates, it is only necessary in measuring an object to turn the plates until the image is doubled and ascertain the angle between them, and the table will then give the dimensions.

In fig. 123 the square box between the eye-piece and objective holds the Helmholtz plates which are rotated by the outer milled head, the angles of inclination being read off on the large graduated drums on each side.

It is claimed that by the use of this instrument those errors are avoided which arise in the use of the eye-piece micrometer if the image of the object does not exactly fall in the plane of the micrometer divisions. The angles can moreover be read with greater precision than the micrometer divisions.

Baumann's Callipers with Movable Microscope and Fixed Micrometer.*—T. Baumann's instrument (fig. 124), in which the Microscope is movable and has a fixed micrometer in the eye-piece, is not intended for such minute measurements as the preceding, but was devised for cases for which a vernier is not sufficiently exact, while a screw micrometer is too fine or not sufficiently rapid. It will read to 0·04 mm. In a base plate A A, 200 mm. long, a central groove is cut, along which moves the cylinder *a*. The upper edges of the groove are bevelled off by a cylinder of the same diameter as *a*. The cylinder moves freely along these without attachment of any kind, to avoid errors of tension, &c. To one end of the cylinder is attached a glass plate C, another glass plate B being fixed exactly parallel at the end of A, the two plates forming the jaws of the callipers. The cylinder is moved by the ivory handle at *h*. A plate *u u* is attached to the former on one side, to which plate are fastened the two supports *g* which carry the socket of a compound Microscope *l o* (78 mm. high and magnifying 50–60 times). The supports *g* rest on the base plate. The socket is divided and the two halves are clamped by the milled head *m*. The inside of the socket has a worm so that by turning the ring *k* the Microscope is moved up or down for focusing.

The edge of the base plate is divided on silver for 150 mm. into

* Zeitschr. f. Instrumentenk., iv. (1884) pp. 149–52 (2 figs.).

0·2 mm. The centimetres are numbered with large figures and the millimetres by microscopic figures from 0 to 9. The approximate position of the Microscope is read off by a pointer. One of the smaller figures is always in the field of the view, which is 1·5 mm. in diameter. At *l* is a micrometer which can be rotated in azimuth.

Fig. 124.

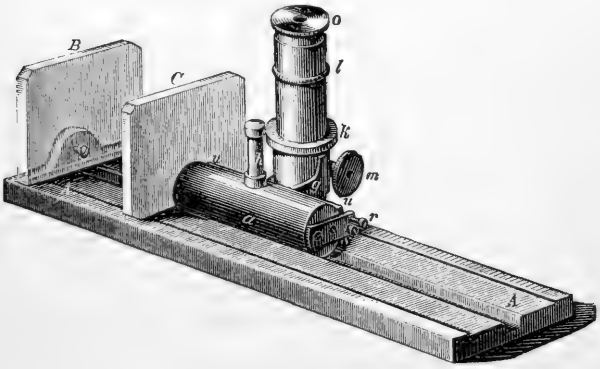
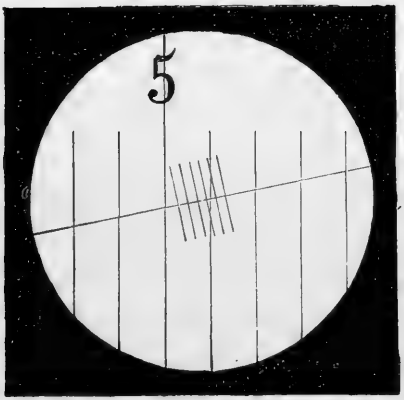


Fig. 125.

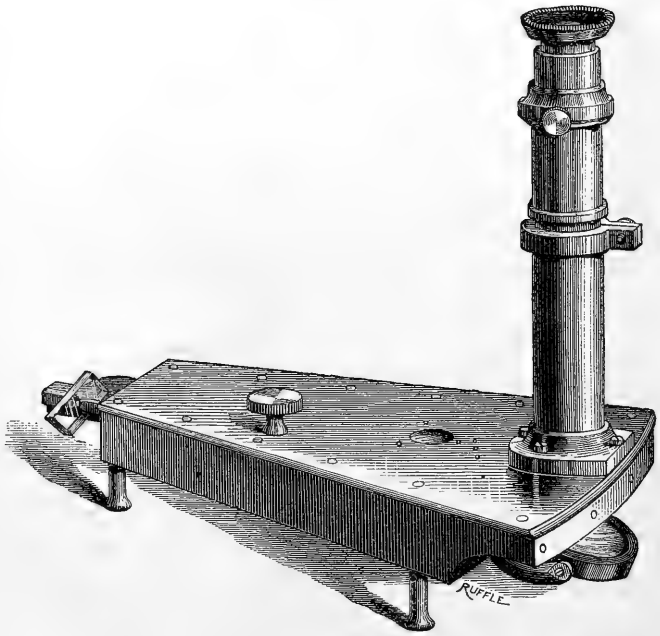


Its five divisions coincide with one of the scale as seen through the Microscope, and each is therefore equal to a fifth of 0·2 mm. or 0·04 mm. The divisions are preferably inclined, as shown in fig. 125. The reading in this case is 4·936 mm. as the last line of the micrometer (reading from right to left owing to the inversion of the image) is 3·4 divisions from the 4·8 mm. point of the scale. As each division is 0·04 mm., 3·4 of these divisions = 0·136 mm. The

coincidence of the 0 point of the scale with that of the micrometer is obtained by the screws *r* and *s* acting on the plate *u u*, which is not rigidly fixed to the cylinder *a*, but slightly movable.

Geneva Co.'s Microscope Callipers.—In the instrument, fig. 126, (made by the Société Genevoise pour la construction d'Instruments de Physique), a compound Microscope is made use of for measuring minute thicknesses such as cover-glass, &c. It consists essentially of a lever at one end of which are the jaws for holding the object to

Fig. 126.

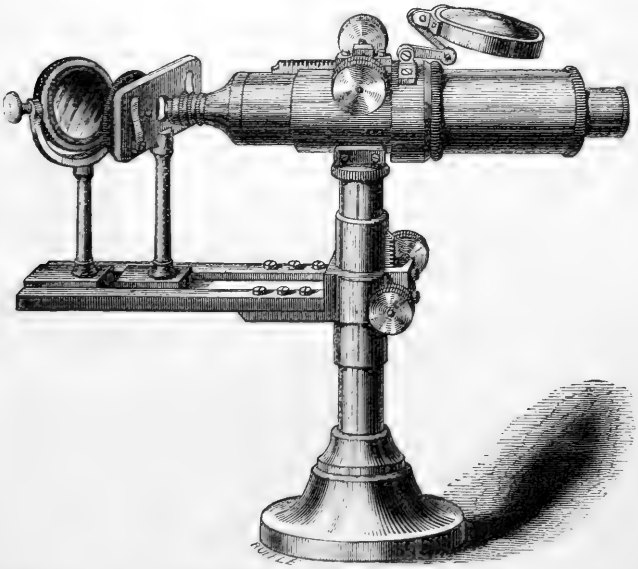


be measured (shown in the figure with a piece of glass between them), and the movement of which is amplified twelve times. At the other end the lever carries a glass plate ruled with 120 divisions, which is observed through a Microscope having a fixed micrometer in the eye-piece with 30 divisions. The jaws are opened by the milled head on the box, and the extent of movement is indicated by a scale with 120 divisions (corresponding to the glass plate), which passes under the aperture seen at the top of the box. By the eye-piece micrometer the principal divisions may be further subdivided. When open the jaws are 3 mm. apart; each of the principal divisions represents therefore 1/40 mm., and the subdivisions 1/1200 mm. The mirror illuminates the divisions of the glass plate.

Griffith's Club Microscope.—Mr. E. H. Griffith writes us that he has further improved the 'Griffith Club Microscope' * as follows: "The bar that holds the clips has a stiff spring over it. The front of the bar is flattened. The clips may be turned back out of the way, and when needed again the spring holds the clips down (or the bar in position). Some have been made with an arrangement to push the bar either way, letting the bar pass through the stage-holder but above it a nut gives the double clips a lateral motion and the spiral spring keeps the bar steady. The double clips clasp the slide and carry it with them. The lamp attachment has been improved also."

Nachet's Class Microscope.—This (fig. 127) was intended by M. A. Nachet to be passed round amongst the students in a class, being at the same time very steady on the table. It can only be used in a

Fig. 127.



horizontal position. The body-tube is focused by the rack and milled heads at the top, while the stage and mirror, which slide on the horizontal bar, are raised or lowered by the milled heads at the side of the standard. The shifting of the object from right to left is effected by the hands.

Nachet's Microscope with Large Field.†—A. Gravis describes a new Microscope by M. A. Nachet, of which the speciality appears to be that it affords a larger field of view than usual in Continental

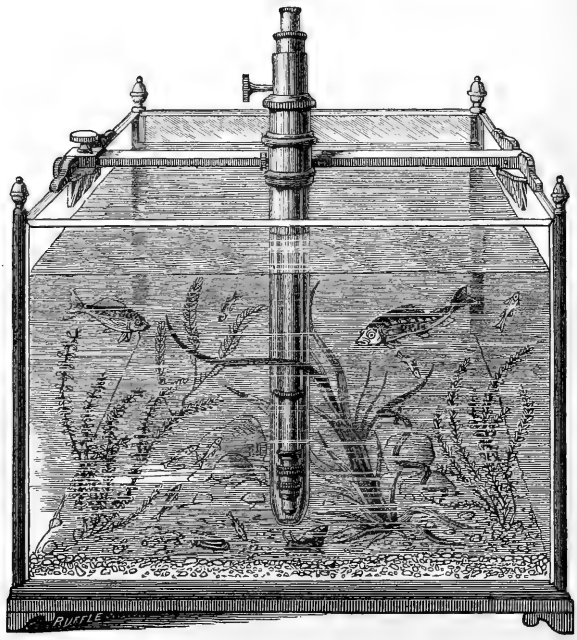
* See this Journal, iii. (1883) p. 113.

† Bull. Soc. Belg. Micr., x. (1884) pp. 194–7.

Microscopes, and is thus specially adapted for dissecting, examining large sections, &c. The tube has an interior diameter of 29 mm., and the apparent diameter of the field measured at a distance of 250 mm. by means of the camera lucida is 200 mm. With the ordinary Nachet No. 1 eye-piece this diameter is only 135 mm., and with No. 1 Prazmowski 110 mm. There is a variable objective, which when shortened gives a magnifying power of 15 with a working distance of 28 mm. and real diameter of 13 mm. When extended these figures are 23, 7 mm. and 8·5 mm. respectively.

Stephenson's Aquarium Microscope.—This Microscope (fig. 128) was designed by Mr. J. W. Stephenson for the examination of living objects in an aquarium.

Fig. 128.



A brass bar is laid across the aquarium, as shown in the woodcut. To adjust it to aquaria of different widths the support on the left is made to slide along the bar, and it can be clamped at any given point by the upper milled head. The milled head at the side, by pressing on a loose plate, fastens the bar securely to the aquarium.

Between the ends of the bar slides an arm carrying a sprung socket, and the arm can be clamped at any given point of the bar. Through the socket is passed a glass cylinder, cemented to a brass collar at the upper end and closed at the lower by a piece of cover-

glass. Into this cylinder is screwed the body-tube of the Microscope with eye-piece and objective, which are thus protected from the water of the aquarium. The Microscope is focused by rack and pinion (milled head just below the eye-piece), and in addition the objective is screwed to a draw tube so that its position in the cylinder may be approximately regulated.

The arm of the socket is hinged to allow of the Microscope being inclined in a plane parallel to the sides of the aquarium. The lower milled head clamps the hinge at any desired inclination. The socket also rotates on the arm so that the Microscope can be inclined in a plane parallel to the front of the aquarium. Thus any point of the aquarium can be reached.

Swift and Son's Oxyhydrogen Microscope. — This (fig. 129) is suitable for use with ordinary objectives from 4 in. to 1/4 in. The gas jet can be regulated for either parallel or convergent light without the necessity of opening the lantern, it being mounted on

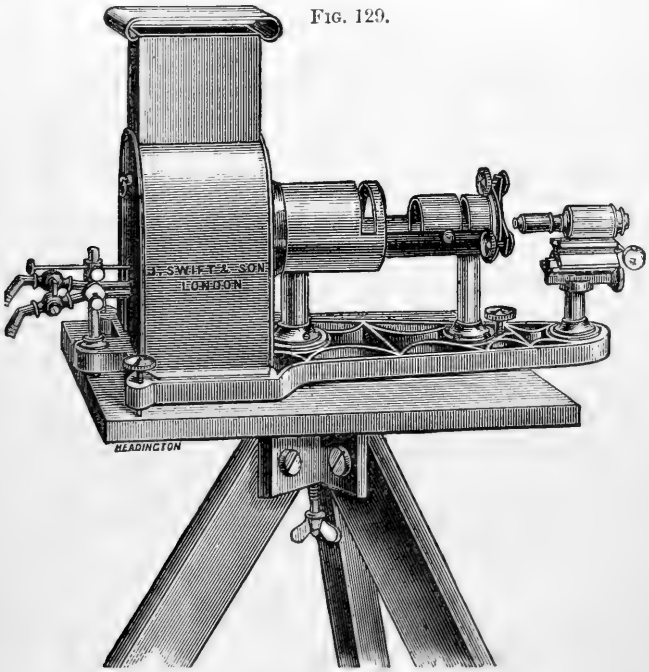


FIG. 129.

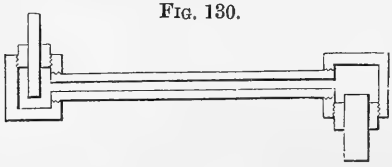
an independent pillar 2 in. from the back, and fitted to adjust to or from the condensing lenses as occasion may require. The perforated metal base renders it very light, and also allows the passage of a free current of air, so that the lantern is kept as cool as possible. There are three screws, upon which the whole is supported to finally adjust

the disk of light. The tube into which the convergent lenses, polariscope, and spot-lens fit, is cut open for the purpose of easily dropping these pieces into position; this opening is covered with a revolving segment of tube similar to the breech action of the Martini rifle.

The stage has rectangular motions by cams which are moved by the milled heads at the back of the stage, and the clip holding the object will equally clamp the thinnest slide or a thick zoophyte trough, the clip is lifted by turning the milled head. The coarse focusing is by rack and pinion, and the fine adjustment is similar in construction to that of the ordinary Hartnack Microscope. The alum trough for stopping the heat-rays can be used behind the condensers for convergent rays, or inserted in the opening in front when parallel light is required, the opening being covered by a revolving segment of tube when not used.

Nelson's Hydrostatic Fine Adjustment.*—E. M. Nelson considers that "the growing increase in the use of wide-angled object-glasses calls for an improvement in the fine adjustments of Microscopes. This is especially the case when it is remembered that depth of focus is inversely proportional to N.A. Also the Microscope is used in a far more scientific manner than the rough and ready way of former days. Among the best workers critical pictures are now the only ones accepted. A vast improvement has taken place in the construction of object-glasses, but the fine adjustments are pretty much the same as they were twenty-five years ago. The following diagrams illustrate a method that has occurred to me, and which, if adopted, would, I think, effect an improvement in this direction. It is simply an iron chamber filled with mercury, with a plunger and a ram. The fine adjustment screw works on the plunger, and the ram on a stud fixed to the nose-piece, which is kept pressed against it by a spring. Fig. 130 shows the arrangement as adapted to a bar movement. Here there are two chambers connected by a pipe, the

Fig. 130.



plunger being in one, the ram in the other. Fig. 131 shows the same thing adapted to a Jackson-Lister. It will be observed that the fine adjustment screw may be on either side or behind the bar. Fig. 132 shows it as arranged for the Continental or medical student's model, which has the direct-acting, non-geared-down, screw fine adjustment. The application of this contrivance to these Microscopes would be invaluable, as their present fine adjustments preclude the possibility of any fine work being done with them. As drawn, the

* Paper read at Quek. Micr. Club. Cf. Engl. Mech., xxxix. (1884) p. 576 (3 figs.).

apparatus gears down 1 : 4, but by varying the relative diameters of the plunger and the ram the ratio could be reduced almost to any extent—e g. a plunger of 1/12 in. and a ram 1/2 in. would gear down

Fig. 131.

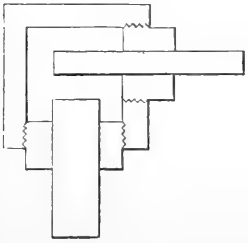
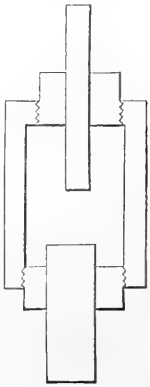


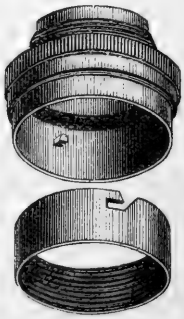
Fig. 132.



in the ratio of 1 : 36, so that one revolution of a 50-thread screw would only make a movement of 1/1800 of an inch in the objective."

Griffith's Nose-piece.—Mr. E. H. Griffith suggests yet another form of nose-piece as shown in fig. 133. The adapter has a short pin fitted on the inner surface of the cylinder, while the ring for the objective has a bayonet slot. The ring is as deep as the Society-screw to the objective, allowing it to be put into the box with the latter. This device was employed by Chevalier many years ago.

Fig. 133.



Kellner Eye-piece with additional Lens as a Condenser.—At the closing meeting of the last Session, after Dr. Wallich had pointed out the advantages of his new form of condenser, Dr. R. L. Maddox explained the plan he had used for some time, especially when photographing minute objects, such as bacteria. Instead of the usual pin-hole in the cap of a Kellner eye-piece, he substituted a movable diaphragm, with a small deep lens of 1/12 in. radius and of some thickness. The diaphragm, with lens duly centered, slides by friction in the cap of the eye-piece, and is pushed up close to the ordinary opening; the cap is then closed down upon the eye-lens to the best position for the purpose required. Single lenses of other radii can also be tried. The whole is used as a substage condenser, and with or without the usual diaphragm wheel.

The advantage claimed for this form is its inexpensive addition to what is ordinarily part of the apparatus of the microscopist. It can be used as an ordinary or immersion condenser, and when employed for photo-micrography, on looking along the path of the illumination from behind, a ring of light is observed round the edge of the field lens, equally divided by a narrow vertical image of the flame, if all the parts be correctly centered.

Osborne's Diatomescope.*—Lord S. G. Osborne calls attention to a little instrument he has invented, which he thinks "may, when once known, be of great service to those observers who, like myself, take great interest in the study of the beautiful forms found in the diatom class of objects.

I have now, for a very long time, worked patiently in an endeavour to procure the means of viewing these objects by oblique light. I possess many of the modern inventions for the purpose; with all I could get much good result; but I yet failed with them to arrive at my chief aim—to possess means of a simple character, easy to use, capable of being put into the market at small cost, which should give with all powers, from 1 in. to 1/4 in., a perfectly black background, the objects under observation brilliantly illuminated.

I have now done this, and the rough models made by my own hands have been seen in use by some well-skilled observers, who have all admitted that my purpose has been fully achieved.

It was my first intention to have simply published in your columns the formula for the construction of the instrument; but having had to make a great many with my own hands, experience taught me that it would be far better to employ skilled labour to act in the first instance under my own supervision to secure accuracy, than to risk the disappointment in the case of those who, wanting my practical experience, might well fail to get all the nicety of adjustment necessary for success.

I therefore have gladly availed myself of the offer of Mr. Ernest Hinton, who has had much experience in connection with the mounting of diatoms, to aid me in getting the little apparatus accurately made. . . .

The instrument is applicable to the stage of any stand which has the usual lateral and vertical movements, and if there is a clamp to keep the slides *in situ*, nothing more is wanted; failing the existence of a clamp, two small pegs fixed to the instrument to drop into two holes in the sides of the stage will answer equally well. If, as in some of the small stands, the aperture in the stage is circular, no clamp is necessary, as the instrument can be set in a piece of tubing to drop into this, with a narrow thin flange to prevent its falling through.

In whatever way it is applied to the stage, the method of use is very simple. The stage being set central, the diatomescope is either laid on it, or, as above, dropped into it. It is well to have a pilot slide. I always use the '*Orthosiren*.' Place this in the springs,

* Engl. Mech., xxxix. (1884) p. 561.

focus the mirror so as to throw light through the slide; with very little manipulation of stage and mirror you will find there is a position of the field in which, with 1-in. power, the centre of the slide has the objects illuminated on dark ground. A very little practice will effect this. You can now change for any object of the class you wish, not moving either mirror or stage; but you will find that if you now put on, say, a 1/4-in. objective, you may have to move the stage a very little to get the full effect; you will also find that by using lateral movement only you will get with the high powers at the edge of the dark field a pearl-coloured light, giving most beautiful definition.

From some that I have constructed with very small lenses I have been astonished to find the comparatively large field I obtain. I get by the above means a result such as I had never conceived possible—effects most beautiful; good slides of *P. angulatum* (Möller's) with 1/4 in. are lit up as with electrical light, on what I may well call perfect black background, and this with wonderful definition. The way all the beautiful markings of all the coarser diatoms are brought out is most satisfactory. The *Podura* and other scales I certainly never had really seen before as I can now see them. With a Zeiss 1/14 I get beautiful definition of everything short of *A. pellucida*.

What I chiefly claim for the invention is, however, not simply the results thus obtained, but that they can be so obtained with scarce any trouble by a simple apparatus of small cost, thus giving to those who cannot afford the more or less costly affairs now in use equal means of enjoying the study of this class of objects.

I have fitted some to the substage of my large stand with advantage; but these would be more costly, as they require a different position of the parts of the instrument, and are not so readily applied.

I have arrived at one fact in experimenting, which I have not the scientific knowledge to explain. Say that I have some *P. angulatum* well shown with high power, and that the background is very black; strange (to me) to say, by shutting in the binocular prism it makes this ground even darker still. . . . I use no condenser to throw light on the mirror, only a common reading-lamp with small flame; either this, or the white cloud of daylight, answers every purpose. The apparatus is constructed to work with the source of light on the left hand."

S. C. S. says * that the above "leaves microscopists no wiser than they were before," and "hopes, if his lordship really wishes to benefit his fellow-workers with the Microscope, he will publish his formula for the construction of the Diatomescope," but this his lordship objects to do.†

Hardy's Collecting Bottle.‡—Mr. J. D. Hardy devised this apparatus for collecting and examining aquatic specimens whilst out on excursions. It consists of two plates of glass with a narrow strip

* Engl. Mech., xl. (1884) p. 18. † Ibid., p. 38.
‡ Journ. Quek. Micr. Club, ii. (1884) pp. 55–6.

of thick indiarubber cemented between them on three sides, the fourth side being left open, and thus forming a very convenient flat bottle for the side coat-pocket. The space between the glasses is sufficient to allow of *Anacharis* 5 in. long being inserted without pressure, at the same time enabling the collector to bring all parts of the weed into good focus. By the insertion of an indiarubber flat cork the bottle is rendered water-tight, and can be used as a slide on the stage, so as to obviate the necessity of disturbing the weed should any object of interest be observed when collecting.

Mr. Hardy also proposes a simple and effective method of straining the water poured into or out of an ordinary wide-mouthed collecting bottle, viz. by means of a small cylinder of copper wire gauze, which extends above the neck of the bottle.

Eye-piece Amplification.—Prof. Abbe points out that his view as to the comparatively low eye-pieces which the best Microscope objectives of the present day will usefully bear * is supported by the recognized rules for telescopes.

"The essential principle for a valid comparison of the telescope and the Microscope is that every Microscope involves in its action that of a given telescope. The effect of the Microscope cannot in any case extend farther than the effectiveness of such telescope. Now the most trustworthy power of eye-piece for a telescope is approximately 40 per inch of the diameter of the objective, i. e. 1/4 in. focal length for every telescope in which the proportion of focal length to aperture is 1 : 10. This relation of eye-piece to objective in the telescope is exactly paralleled in the Microscope when to a 1/8 in. dry objective of maximum aperture is applied (with a 10-in. tube) a 1 in. eye-piece, or a 3/4 in. eye-piece with a homogeneous immersion 1/8 in. of 1·33 N.A.

If therefore it is contended that Microscope objectives can usefully bear the application of a 1/4 in. eye-piece, it must at the same time be contended that a telescope will bear a useful power of 120 per in. aperture!"

Illumination and Focusing in Photo-Micrography.†—Dr. R. A. Hayes, after considerable experience with electric (arc) magnesium, lime, gas, and oil-lamp lights, finds that only the lime-light and the oil-lamp fulfil the necessary conditions required in the case of a source of artificial light for photo-micrography which shall at the same time have light-illuminating power, be perfectly steady, possess very active actinic properties, and be easily produced and maintained. The use of the oil-lamp being confined to cases where the magnifying power does not exceed 50–100 diameters; or in other words, to the 1 in. or 1/2 in. objective. The difficulty as to the intensity of the light is not so much in reference to the exposure of the plate, as to

* "Usefully" that is in the sense defined in Prof. Abbe's paper, Vol. III. (1883) p. 790, and not merely "useful" for an amusing exhibition of the diffraction phenomena.

† Proc. R. Irish Acad. (Sci.) iv. (1884) pp. 59–61.

the impossibility of getting the image focused in a satisfactory manner, the great rapidity of the dry gelatine plates now in use making the time of exposure quite a secondary matter.

The arrangement for making the photographs is as follows:—In front of the condenser of the lime-light lantern is fixed a tube 10 in. in length, at the further end of which is placed a plano-convex lens, of about 2 in. focal length, mounted in a sliding tube movable by rack and pinion, the beam of light passing through which comes to a focus, and then while only slightly divergent falls on the achromatic condenser fixed in the substage of the Microscope. This arrangement gets rid of most of the heat-rays; the beam passing through the condenser traverses the object to be photographed, the image of which is projected directly on the screen by the object-glass, no eye-piece being used. For focusing, a sheet of glazed white paper is used pasted on a glass plate placed in the dark slide. By focusing in this manner as one sits in front of the screen the various adjustments of the Microscope and condensers are easily made, while keeping a distinct view of the image.

As regards the details of focusing the image, he adopts the following method:—

The object having been brought into the desired position and roughly focused, it is then by means of the mechanical stage removed from the field, and the diaphragm aperture which is intended to be used in the particular case having been placed in position, the achromatic condenser and light are manipulated until the field is evenly illuminated; the diaphragm plate is then revolved until the full opening is reached; the object is then brought back into position, and the best possible image obtained by means of the fine adjustment; the diaphragm plate is then again returned to its former position; the image, of course, gains much in sharpness, and although quite sufficiently bright to produce an impression on a rapid plate, is not at all in as satisfactory a condition for accurate focusing as when presenting a brighter appearance.

When all the adjustments have been made, the sleeve suspended from the frame is placed in position, one end of it being attached to the sliding front of the camera, and the other end to a pasteboard cylinder, which fits on to the back of a narrow box, containing a sliding shutter by which the exposure is made. To the front of this box the body of the Microscope is attached by a small black velvet sleeve which completes the camera. The large sleeve is made of mackintosh cloth, with three hoops fastened inside to prevent its collapsing.

Mitchell's Focusing Glass for Photo-Micrography.*—G. O. Mitchell, finding that no matter how finely the focusing screen was ground, it would not allow the finer details of objects to be seen, made use of a Huyghenian eye-piece in the following manner. A narrow strip of thin board, 15 × 2 × 3/8 in., had a circular hole cut in its centre through which the eye-piece could be just forced with con-

* Amer. Mon. Micr. Journ., v. (1884) p. 81 (1 fig.).

siderable pressure and a screwing motion. Throwing back the ground-glass screen and allowing the projecting ends of the strip to rest upon the edges of the camera, as clear and distinct an image was obtained as in looking through a Microscope.

To adjust the glass to the position occupied by the plate during exposure, focus with the ground-glass screen upon a printed text placed at some distance from the camera, using an ordinary view lens and getting the edges of the letters as sharp as possible. Then throwing back the screen and being careful not to change the position of the bellows, apply the eye-piece with its carrier resting against the edges of the box, and screw it in or out till the sharpest and clearest focus is obtained, making a mark upon the eye-piece to serve in case of accident.

When an objective is used which is not well adapted to photographic work, owing to the difference between the focus for vision and that for actinic rays, the eye-piece can be so adjusted, by experiment, that when the image is sharp as seen in the eye-piece the actinic rays will be focused on the plate.

Photo-Micrography in Legal Cases.*—Dr. W. T. Belfield points out that among the numerous applications of photography, none is more satisfactory to the operator than photography with the Microscope in legal cases, it being indeed the only way for conveying to judge or jury absolutely accurate and faithful conceptions of the microscopic appearances upon which the expert microscopist bases his evidence.

It is naturally and notoriously difficult to present technical evidence clearly to a jury; and this difficulty arises not necessarily from any lack of intelligence on the part of the jury, but simply from their lack of technical knowledge of the subject in question. The difficulty is especially great in presenting facts obtained through the Microscope. The actual exhibition of such objects as blood-corpuscles in court cannot be satisfactorily accomplished, and while drawings made with the Microscope are admissible as means of general *illustration*, they are totally inadmissible as *representations* of absolute accuracy and fidelity to nature.

The photograph is the only method which we at present possess whereby accurate and faithful representations of microscopic objects can be presented to individuals who are not familiar with the instrument.

The author then relates a case coming within his own experience of the application of photo-micrography to the determination of a legal question.

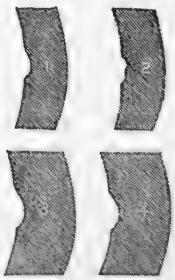
"I was induced to submit hairpins to microscopic examination some months ago under the following circumstances:—In the pocket of Zura Burns, found murdered at Lincoln last October, was found a single hairpin; in the buggy of O. A. Carpenter, suspected of having perpetrated the murder, were found two pins, one of which appeared to be the exact counterpart of the pin found in the girl's pocket.

* 'Photography' (Chicago), i. (1884) pp. 54–9 (7 figs.).

The prosecuting attorney inquired of me whether or not the Microscope would reveal additional proofs of the similarity of the two pins. I had at that time never made a critical examination of hairpins with the Microscope, and was not aware that such examination had been made by others; I so informed him. I was commissioned to investigate the subject.

The two pins were of the pattern known as the 'crimped' or curvilinear hairpin; I therefore directed my investigation to the structure of these pins and the mode of their manufacture. I found that these 'crimps' are made by a punch which bends the wire; and it became evident that the pins made in the same machine would probably exhibit the same punch marks or indentations at the curves. An examination of numerous packages of crimped hairpins showed that such was actually the case; all the pins from a given package as bought in the store, showed precisely the same marks at the same points on the pin. Pins of different manufacture, even though similar to the naked eye, showed different punch marks, corresponding to their production in different machines. Nos. 1 and 2, Fig. 134, are specimen punch marks, the two pins photographed having been obtained from different packages. Of course merely a small fragment of the pin is represented.

FIG. 134.



All the hairpins contained in the package from which No. 1 was taken, exhibit the same indentation at the same point on the pin; all of those in the package from which the second hairpin was taken, exhibit the same mark as is pictured in No. 2. However close the resemblance to the naked eye, therefore, such pins can be readily identified or distinguished with the aid of the Microscope by means of these marks.

The two hairpins already mentioned in connection with the Carpenter case were sent by express to my address; one of them—that found in the girl's pocket—was unfortunately lost *en route*. Upon examining the other with the Microscope, I found that it presented four distinct machine marks, the most prominent of which is represented in No. 3. The loss of the other hairpin seemed at first to vitiate the value of the information which might probably be derived from a comparison of the two. However, it was ascertained that on the morning of her departure from home (in St. Elmo) for Lincoln, the girl's father had purchased for her at a country store a package of pins, some of which she had used in making her toilet, the remainder being placed in her pocket. The prosecuting attorney forthwith bought all the hairpins in stock at the store where this purchase had been made. The stock was found to consist of the one variety of pin from which a small packet had been sold to the girl's father. Microscopic examination of these pins showed precisely the same machine markings as were exhibited by the pin found in Carpenter's buggy. A photograph of the indentation on one of these

pins from the St. Elmo store is copied in No. 4. I was thus enabled to assert that the pin found in Carpenter's buggy must have been made in the same machine as those used by the girl just before the murder.

These pins were, moreover, of a peculiar pattern; among eighty packages purchased in Chicago and in Lincoln, and some twenty odd hairpins obtained at random, I did not discover a single pin exhibiting the same markings. The scarcity of pins of this pattern was afterwards explained by the fact that the factory in which they had been made was closed eleven years ago. The rarity of hairpins made in this particular machine combined with the presence of one of them found in Carpenter's buggy, rendered it highly probable at least that the girl had ridden in this buggy."

American Society of Microscopists.—The deputation (Dr. Dallinger and Mr. A. W. Bennett*) appointed to represent our Society at the Rochester, N.Y., meeting of the American Society have not yet returned from America, so that we are not in a position to give any authentic report of the proceedings of the meeting, but we understand from private sources that nothing could exceed the courtesy and warmth with which the deputation were received by our American brother microscopists, everything being done to testify to the friendly feeling entertained for our Society on the other side of the Atlantic. We are sure that Dr. Dallinger and Mr. Bennett did not leave unacknowledged at the time the courtesies extended to them, but the appreciation of the Society at large will remain to be expressed at the ensuing meeting, by which time it is anticipated that the deputation will have returned.

The toast of "The Royal Microscopical Society" was proposed at a supper given to the American Society, and Dr. Dallinger was elected an Honorary Fellow.

Health Exhibition. — The connection of this exhibition with health is, as is generally recognized, one of a very slender kind, and it is to be regretted that such a department as the Biological Laboratory, which in a true "health" exhibition would have occupied a prominent place, is relegated to the comparative obscurity of the topmost rooms of the lofty City and Guilds Institute.

The laboratory is under the charge of Mr. W. Watson Cheyne, M.B., who exhibits a large series of microbes of various kinds, isolated and growing in the media suited to them. The laboratory contains examples of fungi injurious to animals or plants, or altogether innocuous; and it is well equipped with apparatus and appliances, including incubators, sterilizers by steam and dry air, aspirometers, and Microscopes; there are also 36 photo-micrographs and some diagrams, among the latter of which are those that illustrate the excellent influences of vaccination and re-vaccination, and show that in later years no German soldier has died of small-pox, and that in some years only 2·12 in 100,000 have been ill of it. Many of the

* Mr. Glaisher was unfortunately prevented from attending.

specimens and most of the diagrams have their origin in Dr. Koch's laboratory. On Thursday afternoons microscopical preparations are exhibited, and at 4 P.M. on that day Mr. Cheyne gives a demonstration.

Microscopes and apparatus are exhibited by Messrs. Beck, Powell, Swift, Watson, and other makers.

American Society of Microscopists.
[Further Notes as to the Rochester Meeting by G. E. Davis, R. Hitchcock, C. H. Stowell, D. S. Kellicott, E. H. Griffith, and E. Bausch.]
Micr. News, IV. (1884) pp. 195–6.
Amer. Mon. Micr. Journ., V. (1884) pp. 136–7, 139.
The Microscope, IV. (1884) pp. 160–1, 162–3, 163–4, and 164–5.

Baumann, T.—Ueber einen Scalen-Taster mit festem Mikrometer im Mikroskop. (On Callipers with fixed Micrometer in the Microscope.) [*Supra*, p. 794.]
Zeitschr. f. Instrumentenk., IV. (1884) pp. 149–52 (2 figs.).

Bausch and Lomb Optical Co.'s New Illuminator. [*Ante*, p. 623.]
Amer. Mon. Micr. Journ., V. (1884) p. 126 (1 fig.).

Behrens, W.—Eine neue Construction des Abbe'schen Beleuchtungsapparates. (A new Construction of Abbe's Illuminating Apparatus.) [*Post.*]
Zeitschr. f. Wiss. Mikr., I. (1884) pp. 409–12 (1 fig.).

Blandy, H.—Culpepper's Microscope.
[Description of one.] *Engl. Mech.*, XL. (1884) p. 97.

Bottone, S.—See Wright, L.

Bulloch, W. H.—"Falsus in uno, falsus in omnibus."
[Further reply to Prof. McCalla in regard to the Congress Nose-piece.]
The Microscope, IV. (1884) p. 163.

Cooke, M. C.—The President's Address (1884).
[To "serve as a caution to some of our younger members, and at least convince them that an old microscopist of 40 years' experience believes it to be his duty to warn them of one of the vices of the age, and to put them on their guard against exaggeration."]
19*th Report Quekett Micr. Club*, 1884, pp. 9–18.

D., E. T.—Graphic Microscopy. VIII. Spiracle of Breeze Fly (*Œstrus equi*). IX. Polypidom of *Lepralia nitida*.
Sci.-Goss'p, 1884, pp. 169–70 (1 pl.), 193–4 (1 pl.).

Dallinger, W. H.—The Lowest and Smallest Forms of Life as revealed by the Modern Microscope.
[Some of the principal passages of lecture at the Montreal Meeting of the British Association. *Supra*, p. 721.]
Times, 2nd September, 1884.
Engl. Mech., XL. (1884) pp. 10–1.

Davis, G. E.—Objective Changers.
["We have never found the so-called instantaneous changers to enable more work to be done, and we have even discarded the double nose-piece in ordinary work."]
Micr. News, IV. (1884) p. 218.
" " Proceedings of Provincial Societies.
Micr. News, IV. (1884) p. 218 and p. 215.

Dudley, P. H.—[Exhibition of Photo-micrographs of sections of American timber-trees taken with ordinary lamp-light and enlarged 100 diameters.]
Bull. Torrey Bot. Club, XI. (1884). p. 84.

Ermengem, E. Van.—Microphotographies obtenues à l'aide des plaques isochromatiques préparées par Clayton et Attout-Tailfer. (Micro-photographs made with the isochromatic plates of Clayton and Attout-Tailfer.) [*Post.*]
Bull. Soc. Belg. Micr., X. (1884) pp. 170–2.

GIACOMINI.—Nuovo Microscopio per l'esame delle sezioni dell'intero encefalo umano adulto. (New Microscope for the examination of sections of the entire human adult brain.) [*Post.*] *Giorn. R. Accad. Med. Torino*, 1883 (1 fig.). *Gazz. delle Clin.*, 1883, p. 528. Cf. *Zeitschr. f. Wiss. Mikr.*, I. (1884) pp. 427–9 (2 figs.).

GRAVIS, A.—Microscope à grand champ de A. Nachet. (Microscope with large field of view, by A. Nachet.) [*Supra*, p. 797.] *Bull. Soc. Belg. Mikr.*, X. (1884) pp. 194–7.

GROVE, W. B.—A Synopsis of the Bacteria and Yeast Fungi and Allied Species. (Schizomycetes and Saccharomycetes.) [Contains Appendix A, pp. 101–2, "On the Unit of Micrographical Measurement" [*post*], and Appendix B, pp. 103–4, "On the staining of '*Bacillus tuberculosis*,'" describing Koch's, Ehrlich's, Gibbes', and Prideaux's methods (*supra*, p. 787).] vi. and 112 pp. (87 figs.), 8vo, London, 1884.

GUÉBHARD, A.—Puissance et grossissement des appareils dioptriques. (Magnifying power of dioptric instruments.] [*Post.*] *Rev. Scientifique*, XXXI. (1883) pp. 804–11 (5 figs.). Transl. *Centralztg. f. Optik. u. Mech.*, V. (1884) pp. 183–8 (6 figs.), 194–7.

HANAUSEK, E.—Eine zweckmässige Mikroskopierlampe. (An effective microscopical lamp.)

[A petroleum lamp made by Rob. Rühe, at Landsberg a. W. Over the glass chimney is placed a metal structure of white composition, consisting of a conical tube inclosing the glass chimney, to which is attached a fixed metal cylinder placed obliquely. This latter is closed at the lower end by a convex lens of small curvature, and permits the application of a blue glass plate.]

Fachztg. f. Warenkunde, 1883, No. 6, p. 32. Cf. *Bot. Centralbl.*, XVIII. (1884) p. 53.

HAYES, R. A.—Notes on Microphotographic methods. [*Supra*, p. 804.] *Proc. R. Irish. Acad.* (*Sci.*), IV. (1884) pp. 59–51.

HEURCK, H. VAN.—Entgegnung auf den Artikel des Herrn Stein: Die Verwendung des elektrischen Glühlichtes zu mikroskopischen Untersuchungen, &c. (Reply to Stein's paper, "The application of the electric incandescence light to microscopical investigations, &c.)

[Same as the French protest, *ante*, p. 632.] *Zeitschr. f. Wiss. Mikr.*, I. (1884) pp. 419–22.

HITCHCOCK, R.—The Electric Light in Microscopy. [*Post.*] *Amer. Mon. Micr. Journ.*, V. (1884) pp. 138–9.

„ „ Growing Slides, or Microscopical Vivaria.

[Charters White's, and J. D. Hardy's, I. (1881) p. 671.] *Amer. Mon. Micr. Journ.*, V. (1884) p. 141 (1 fig.).

HOLLEY, G. W.—Suggestions for improvement in the manufacture of glass. . . .

[Proposal "to improve the quality of glass by introducing silver into its composition."] *Journ. Frankl. Institute*, CXVIII. (1884) pp. 132–8.

JANNEY, R.—Simple Solar Microscope. [*Post.*] *Scientific American*, L. (1884) p. 276 (1 fig.).

KORITSKA, F.—Norme pratiche per l'uso del Microscopio. (Practical rules for the use of the Microscope.) 14 pp. 32mo, Milano, 1883.

LIMONT, W.—Notes on Modern Forms of the Microscope.

["When it can possibly be afforded, an English skeleton Microscope on the American (Jackson-Zentmayer) model should be got by students and others. . . . In no case is it a good investment to buy a foreign first-class instrument, and in most cases a first-class English 'skeleton' Microscope should be got in preference to a third-class Microscope, either English or foreign."] *Proc. Phil. Soc. Glasgow*, XV. (1883–4) p. 118.

MERCER, F. W.—Incandescent Lamps and Accumulators in Photo-micrography.

[Describes Swan and Edison lamps, and a "small and very portable accumulator made on the Faure principle," with practical directions.] *Photography*, I. (1884) pp. 147–9 (4 figs.).

M'Intosh, L. D.—Lanterns for Projection.
[Includes microscopic projections.]
Photography, I. (1884) pp. 131–4 (6 figs.).

Moeller, J.—Ein neues Präparirmikroskop. (A new dissecting Microscope.) [*Ante*, p. 613.]
Zeitschr. f. Wiss. Mikr., I. (1884) pp. 412–3.

Moore, A. Y.—Beck's Vertical Illuminator and Immersion Objectives.
[Description and directions for use. Also as to coating diatoms with silver, *infra*, p. 829.]
The Microscope, IV. (1884) pp. 157–9, 165.

" " The Fakir's Secret.
[*À propos* of F. L. James's account of the exhibition of paste eels as animalcules in water, *ante*, p. 146. The secret is probably the use of a few drops of cider vinegar, which promotes the growth of the eels.]
The Microscope, IV. (1884) pp. 170–1.

Nelson, E. M.—A hydrostatic fine adjustment. [*Supra*, p. 800.]
Engl. Mech., XXXIX. (1884) p. 576 (3 figs.).

" " Microscope Tube-length.
[Reply to query. "Place an object on the stage accurately centered and focused to the objective whose back focus is to be measured. Centre the substage condenser, and focus by it the edge of a flame on the object. Remove the object out of the field, leaving slip and cover-glass between objective and condenser. Take out the eye-piece. Insert down the tube of the Microscope a smaller tube having its lower end closed by a diaphragm of paraffined tissue paper. Slide this up and down until the image of the flame is focused on it, which will give the solution to the first part of "B. C.'s" question. By pushing the tube further down until the smallest spot of light is found, the place where the rays cross can be determined."]
Engl. Mech., XXXIX. (1884) p. 589.

" " Plane Mirror for Microscope.
[Reply to query. "I find it difficult to write a complete answer to 'Mirror's' question within reasonable limits, there being so many combinations and varieties of methods of illumination, each of which demands a separate consideration before the reply could be termed exhaustive. 1. When using artificial transmitted light with substage condenser, I, if possible, dispense with the mirror altogether and work direct; but when this is not possible, I use the plane mirror. 2. With lamplight, but without a substage condenser, concave mirror. 3. Diffused daylight without substage condenser, concave mirror with high and medium powers, plane with low. 4. Diffused daylight with substage condenser, always plane mirror. 5. Dark ground with lamp-light and bull's-eye, always plane mirror."]
Engl. Mech., XXXIX. (1884) p. 593.

" " Illumination for the Microscope (*in part*). [*Post.*]
Engl. Mech., XL. (1884) p. 68 (2 figs.).

Osborne, S. G.—The Diatomescope. [*Supra*, p. 802.]
Engl. Mech., XXXIX. (1884) p. 561 and XL. (1884) p. 38.
Also letter by S. C. S., XL. (1884) p. 18, *supra*, p. 803.

Pease, J. L.—The Facility Nose-piece.
[Description of it. *Ante*, p. 425.] *The Microscope*, IV. (1884) p. 171.

Plehn, J.—Apparat zur Prüfung der Brennweite des Auges oder anderer optischer Systeme. (Apparatus for testing the focal length of the eye or other optical systems.)
German Patent, Kl. 42, No. 27,860, 27th January, 1884.

Purser, J. M.—See p. 839.

[Redding, T. B.]—The Microscope. Its uses and revelations.
Indianapolis Journal, 16th August, 1884, p. 10.

S., S. C.—See Osborne, S. G.

Schöffler und Smolarz.—Das elektrische Gewehr, elektrische Minenzündung, elektrische Distanzmesser und das Gastroskop. 8vo, Wien, 1884, pp. 93–109. (17 figs.). Extr. from 'Die Elektricität und der Magnetismus.'

[Describes the Gastroscope, III. (1883) p. 420.]

Sexton's (L. R.) retirement from business.

Amer. Mon. Micr. Journ., V. (1884) pp. 158–9.

St. Clair, G.—Note on a possible source of error in photographing Blood-corpuscles. [*Post.*]

Nature, XXX. (1884) p. 495.

Stein, T.—Die Verwendung des elektrischen Glühlichtes zum mikroskopischen Untersuchungen und mikrophotographischen Darstellungen. (The application of the electric incandescence light to microscopical investigations and photo-micrography.)

[Additions to his original paper, *ante* p. 466, describing the battery of five elements which he uses.]

Centralztg. f. Optik u. Mech., V. (1884) pp. 170–1 (1 fig.).

Stewart, C.—Polarized Light.

[Report of Demonstration.] *Journ. Quek. Micr. Club*, II. (1884) pp. 37–41.

St. Joseph (Mo.) Microscopical Society formed.

The Microscope, IV. (1884) p. 165.

St. Louis Society of Microscopists.

[Adoption of a rule requiring each member to furnish six slides annually to the Society's cabinet.]

Science Record, II. (1884) p. 233.

Stowell, C. H.—High angles or low angles?

[As to the superiority for a physician of a 1/4 in. objective of 75° over one of 100°.]

The Microscope, IV. (1884) p. 180.

" " Mr. Griffith's new box.

[Facetious anecdote of a person to whom Mr. Griffith exhibited his Microscope and who thought the box the "handsomest he ever saw."]

The Microscope, IV. (1884) pp. 180–1.

Tolman, H. T.—Photo-micrography with an Eye-piece.

[Directions for photo-micrography generally.]

Photography, I. (1884) pp. 124–6.

Viguier, C.—Note sur un nouveau Compresseur à verres mobiles. (Note on a new compressor with movable glasses.) [*Post.*]

Arch. Zool. Expér. et Gén., II. (1884) pp. xii.–xvi. (5 figs.).

Wales' (W.) High-power lens for use with the Binocular.

[Apparently the same as that described III. (1880) p. 1050.]

Amer. Mon. Micr. Journ., V. (1884) p. 139.

Wheeler's (E.) retirement from business. *Sci.-Gossip*, 1884, p. 184.

Woodward, J. J., death of. *Times*, 17th September, 1884.

Wormley, T. G.—Microscopic Science.

[Abstr. of an address to the Section of Histology and Microscopy of the Amer. Assoc. Adv. Sci.

[Describes the advantages and possibilities of two special applications of the Microscope: first, to the detection of very minute quantities of certain poisons, notably arsenic, by the examination of the sublimate; second, to the examination of blood stains. Also the limits within which identification of different animals, and the recognition of human blood, is feasible; he denied that human blood can be absolutely identified; he also stated that the result of prolonged experiments indicated that pure water is the best reagent for restoring the blood-corpuscles in a stain to their natural condition.]

Science, IV. (1884) p. 244.

WRIGHT, L.—Micro-photography.

[Reply to inquiry as to photographing diatoms and diffraction-gratings. Also reply by S. Bottone.]

Engl. Mech., XXXIX. (1884) pp. 519-20.

ZENGER, C. V.—Détermination des Indices de Réfraction par des Mesures linéaires. (Determination of indices of refraction by linear measures.)

[Simple method of strict determination to the 5th decimal by means of a divided rule with a small telescope sliding on the alidade which carries the vernier.]

Comptes Rendus, XCIX. (1884) pp. 377-80.

β. Collecting, Mounting and Examining Objects, &c.

Killing Infusoria.*—J. P. McMurrich finds that for killing infusoria, provided only a temporary preparation is required, a saturated solution of corrosive sublimate in water is the most useful he has tried. A drop or two run under the cover-glass produces almost instant death without any of the shrinkage so annoying even with osmic acid. After this treatment staining with anilin blue, black, or Brunswick brown takes place very rapidly and very satisfactorily.

Perchloride of Iron.†—H. Fol has overcome some of the inconveniences of this reagent and has made it "really practical." The iron salt may be completely extracted from a preparation fixed by being for 1/2–1 hour in the perchloride, diluted with alcohol, by washing with an aqueous solution of oxalate of potash, or an alcoholic solution of oxalic acid. The tissues can then be preserved in weak alcohol and stained with success by the ordinary process, using carmine, hæmatoxylin, and anilin dyes.

The author adds "These preparations are only distinguishable from those obtained by the usual fixing agents by the extraordinarily faithful preservation of the vibratile cilia, the pseudopodia, and the nuclear filaments."

Mounting of Foraminifera—New Slide for Opaque Objects.‡—Dr. F. M. Hamlin considers that for the finest forms, and for calcareous sands, such as the famed Bermuda sand, there is no plan so satisfactory as to search through the material with the Microscope, to save time and labour separating the sand into grades by passing it through sieves of three different degrees of fineness. The shells from the last will exercise the skill nearly as much as diatoms. Having sifted the sand, it should be examined on a specially devised slide, made as follows:—A piece of pasteboard the size of an ordinary slide has a long slit cut in it, and is then fastened to a glass slide. The width of this slip is of importance, and is determined thus: Take a low power objective, say a three or four inch, which affords just sufficient power to see the shells well, and measure the width of its field. Make the slit or opening in the pasteboard just twice this distance. The slide being ready, a little pinch of sand is put on the glass, and a slight shake spreads it out in a single layer confined by

* Amer. Natural., xviii. (1884) p. 832.

† Arch. Zool. Expér. et Gén., ii. (1884) p. ix.

‡ Proc. Amer. Soc. Micr., 6th Ann. Meet., 1883, pp. 65-8.

the pasteboard. It is then placed under the Microscope, and moving it so that the edge of the pasteboard is just visible, pass up one side and down the other, and every particle of the sand is brought into view without loss of time in searching over the same portions many times, and perhaps entirely omitting other. It is surprising what a quantity of sand can thus be looked over in a short time by this systematised labour.

The shells may be picked up by a very fine needle dipped in turpentine, or a very small camel's hair brush.

Not being satisfied with the ordinary slides and cells for this class of objects, the author has devised a slide which he thinks serves the purpose admirably; it is made as follows:—The slide itself is of wood, of the ordinary size, and about 1/10 in. thick. Through its centre is bored a hole 1/2 in. in diameter. Over the back of this is pasted a strip of stout paper. The hole in the slide with the paper back constitutes the cell. In the bottom of the cell is pasted a disk of coloured paper, cut with a gun-wad punch, to serve as a background for the "mount." To give a neat finish, a brass curtain-ring which just fits in the hole is fastened in with a bit of cement. The edges of the slide are now bound or covered with coloured tissue paper. The shell may now be arranged in the cell, and the cover-glass dropped in upon the brass ring, the top of which has been covered with cement. A suitable label the whole size of the slide is now pasted on the front, and a plain one may be put on the back.

Should a shell be very rare, and it is desirable to show both sides, a piece of thin glass may be let into the back of the slide, and the curtain-ring placed upon this instead of the paper background. Such a slide would need a hole in the back as well as in the front label.

When these slides are finished with pretty and suitable labels they make a fine appearance, pack and carry as easily as so many slips of wood, and if made of white bass wood do not warp. The porosity of the wood prevents any accumulation of moisture upon the cover-glass.

Hæmatoxylin as a Reagent for Non-lignified and Non-suberized Cellulose Membranes.*—The reagent described by E. Giltay in this paper and which he finds to be very sensitive and preferable in most cases to those hitherto employed for the purpose, is prepared as follows:—

To 5 cc. of a solution of hæmatoxylin (7 grams of hæmatoxylin to 50 cc. of water) add 100 cc. of a solution of alum (3/4 per cent.). The mixture should be prepared two days before it is required, and as it speedily becomes turbid, a small amount is filtered each time before use. The sections to be stained are left in from 5 to 15 minutes, according to circumstances, and subsequently mounted in glycerine, oil of cloves, or Canada balsam. In the last, or in oil of cloves, the colours keep for a long time.

In general this reagent and that of Schultze have the same action

* Arch. Néerland. Sci. Exact. et Nat., xviii. (1883) pp. 437–52.

on vegetable tissues, and they both stain blue. The value of the hæmatoxylin consists, however, in the fact that it does not stain the membranes which are completely transformed into cork or wood. It is therefore well adapted to reveal the unaltered cellulose elements in cell-walls which are imperfectly lignified or suberized. With Schultze's solution, which colours the lignified and suberized parts yellow, the blue colour simultaneously developed in the cell-wall is not brought out sufficiently clearly to enable the extent of the lignification to be determined with certainty.

Canarine for Staining.*—L. Errera finds that canarine, a new colouring matter derived from sulphocyanide of potassium, is specially adapted for sections of stems, and the author adds that it "exercises its staining action in the presence of caustic potash, which will make it without doubt valuable for various researches in vegetable anatomy."

Cultivation of Bacteria upon the Slide. — Dr. Pierre Miquel writes us as follows:—

"The first efforts towards cultivation upon the slide whilst on the stage of the Microscope date far back, and have always attracted the attention of micro-botanists, anxious to follow the germination of microscopic spores, their growth, and fructification. De Bary, Woronin, Brefeld, and many others have carefully studied the arrangements necessary for these delicate cultivations. In France, Van Tieghem and Lemonnier have popularized a very convenient method from their memoir on which the following is derived.†

In the centre of an ordinary slide is fastened, by Canada balsam, a glass ring from 4–5 mm. thick, cut from a tube used for organic analysis, and the cut sides properly ground level. A thin cover-glass, round, and of a sufficient diameter to just cover the ring without overlapping the edge, is fixed on the upper side, by three very small drops of a greasy oil, to complete the cell. In order that the interior air may be always saturated by moisture a few drops of water are placed on the bottom of the cell. A small drop of nutritive liquid is suspended at the centre of the under surface of the thin cover. In this drop are sown the spores for cultivation. This plan allows us to follow, with great facility and without interruption, from hour to hour if required, all the details of the germination, characters of the mycelium, and all the phases of the different fructifications, in a word, the life-history of the plant, however long the time may occupy. It offers all the advantages of cultivation upon the slide as habitually practised without being liable to such errors as may otherwise happen from contamination by foreign germs falling into the nutritive fluid during the period of cultivation.

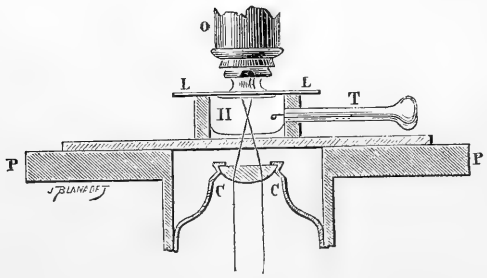
The cultivating liquids employed by these investigators, who were at that time specially occupied in the study of the Mucorini, were of different kinds, as orange-juice, boiled and filtered, or a decoction of

* Bull. Soc. Belg. Micr., x. (1884) p. 183.
† Ann. Sci. Nat., xviii. (1872).

horse-dung, both of which are abundantly provided with azotized principles, or of the so-called mineral liquids proposed by Pasteur and Cohn.

The moist chambers used by Van Tieghem and Lemonnier have during the last ten years undergone many modifications, more or less satisfactory; some investigators have pierced the sides of the little chamber with one or more square holes for the facility of introducing into the interior various reagents, as iodine or ammonia. It is nevertheless singular that these observers have overlooked the chance of these holes permitting the access of dust charged with germs. It is not, however, my purpose to give the history of these moist cells, but simply to describe a method of cultivating the bacteria upon the slide, free from these errors, and which I have employed for the study of the atmospheric Schizophytes. The same cell is made use of, pierced laterally by an opening which can be closed by a small glass rod stopper. Fig. 135 represents the same in section, where O is the immersion objective, L the thin cover with the droplet attached to the

FIG. 135.

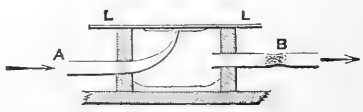


under side, H the moist chamber, T the small glass rod stopper, P the stage of the Microscope, and C the condensing lens. The cells and cover should be attached to the slide by a cement that will not be loosened by the heat used to sterilize the chamber. Afterwards, by the lateral opening, one or several drops of sterilized water for the purpose of keeping the air in the cell saturated with moisture, are placed in the little chamber. Then, by means of a pipette with a curved capillary point, the sterilized nutritive liquid—as blood serum, broth, urine, vegetable juices, &c.—is placed upon the under surface of the thin glass cover, whilst the sowing of the organisms, whose development is to be watched, is accomplished by the aid of a fine platinum wire slightly bent at the point. The small rod stopper is replaced, and the whole with the Microscope is placed in a warm chamber kept at 30° C. If immersion objectives be used, a little glycerine can be added to the water, or cedar oil used on the cover. Good dry objectives and the light from a paraffin lamp generally suffice for the observations, but I give the preference to the excellent No. 7 immersion objective of Nachet. It is not necessary that I

should further describe the precautions required to prevent contamination and the neglect of which may entirely nullify the value of the cultivation."

Another form used by M. Miquel is shown in fig. 136. By the tube A air is projected on the drop of nutritive liquid at the under side of the plate L L, and this having been done, the tube is withdrawn, and the hole closed with a piece of cork; the tube B, which contains some wadding, serves as the aspirator.

Fig. 136.



Dr. Koch describes the method adopted by Hesse for defining the exact quantity of air from which the spores originate. A glass tube 12 in. by $2\frac{3}{8}$ in. is closed at each end with indiarubber coverings, in one of which a glass pipe is inserted, while in the middle of the other is an opening about 3/8 in. in diameter. Gelatine is placed along the bottom of the tube, which is in a horizontal position. The smaller pipe is then placed in connection with an exhausting apparatus and a given quantity of air is forced through, the bacteria and spores falling on the gelatine.

Staining of Schizomycetes in Sections and Dry Preparations.* —C. Gram proposes the following method for producing an isolated staining of pneumonia-cocci, leaving the nuclei and other elements of the tissue uncoloured, the deep staining of the cocci usually found in the sweat-cells causing them to be much more readily found than in ordinary preparations. The method he considers applicable also to almost all examinations of Schizomycetes in sections and dry preparations.

He takes the ordinary Ehrlich's anilin-gentian-violet solution. The sections to be examined for Schizomycetes must be preserved in absolute alcohol and brought direct from it to the staining fluid; here they remain from 1–3 minutes (in the case of preparations of tubercular bacilli from 12–24 hours); then placed in an aqueous solution of potassium biniodide (1 part I, 2 parts KI, 300 parts water), without or after a slight washing with alcohol, where they remain again from 1–3 minutes. A precipitate takes place in the iodine solution, and the sections, previously a dark blue-violet, become a blackish purple-red. They are now laid in absolute alcohol until the colour is again entirely removed, the alcohol being renewed once or twice. They are then clarified in the ordinary way by clove-oil, the remainder of the pigment being given off to the oil. The nuclei and the fundamental tissue are now coloured light yellow by iodine, while the Schizomycetes, if present in the section, are of a conspicuous intense blue colour, often nearly black, the colour being much deeper than in any other mode of staining. After the application of alcohol, the sections may be placed for a moment in a weak

* Fortschr. d. Medicin, ii. (1884) No. 6. See Bot. Centralbl., xviii. (1884) p. 383.

solution of Bismarck brown or vesuvin in order to produce a double staining.

Permanent preparations have been kept for four months without change in Canada balsam, xylol, or gelatin-glycerin. The whole process takes a quarter of an hour, and the preparations may remain for some days in clove-oil without losing their colour. The method can also be applied to dry preparations, the cover-glass being treated as a section. The following diseases were tested for Schizomycetes by this method:—pneumonia cruposa, pyæmia, nephritis suppurativa, arthritis suppurativa after scarlatina, multiple brain diseases, osteomyelitis, typhus, liver abscesses, erysipelas, tuberculosis, cattle distemper, as well as the bacteria of putrefaction. After treatment with iodine the following Schizomycetes remained coloured in alcohol:—The cocci of crupose pneumonia, the Schizomycetes of pneumonia, the cocci of the liver abscesses after perityphlitis, the cocci and small bacilli in circumscribed infiltration of the lungs, the cocci of osteomyelitis, of arthritis suppurativa after scarlatina, of nephritis suppurativa after cystis, those of multiple brain abscesses, of erysipelas, the bacilli of tubercular cattle distemper, and the Schizomycetes of putrefaction. On the other hand, no staining was exhibited of the capsular cocci in a case of crupose pneumonia, or of the capsules without cocci in another case, or of the bacilli of typhus.

Staining Fluid for Sections of Tubercle-Bacilli.* — Dr. Klein recommends a staining fluid devised by Weigert as yielding the finest specimens of tubercle-bacilli in sections through tuberculous growths that he has seen. The sections may be either fresh or hardened.

The fluid is prepared as follows:—Take a 2 per cent. aqueous solution of gentian-violet 12 ccm., and of a saturated aqueous solution of anilin oil 100 ccm. Mix. This is used like an ordinary staining fluid for the first stain. For the second or contrast stain the following solution is used:—Bismarck brown, 1 gr.; spiritus vini rectificati (sp. gr. ·830), 10 ccm.; distilled water, 100 ccm. The sections remain in a few drops of this solution for fifteen minutes. Dr. Klein states that the results obtained by this method are very beautiful, the only drawback being the liability of the colour of the bacilli to fade.

Methods of Imbedding.†—Dr. J. Blochmann reviews the various methods of imbedding, describing in detail those that have come into general use, and pointing out the advantages and disadvantages of each.

In every method of imbedding the principle is the same, namely, to saturate objects with substances which not only fill out the larger internal cavities, but which also penetrate the tissues themselves,

* 'Practitioner,' xxxiii. (1884) p. 35. Sci. Monthly, ii. (1884) p. 92.

† Zeitschr. f. Wiss. Mikr., i. (1884) pp. 218–33 (2 figs.). The above taken from one of Dr. C. O. Whitman's excellent abstracts, Amer. Natural., xviii. (1884) pp. 842-4 (2 figs.).

rendering them (after cooling) sufficiently hard for the process of sectioning.

Glycerin and Gelatin.—Gelatin 1 part; distilled water 6 parts; glycerin 7 parts. For preservation a little carbolic acid (1 gram for 100 grams of the mixture) should be added. Objects are transferred directly from water to the melted mixture, and after complete saturation imbedded in paper boxes. After cooling the objects thus imbedded are hardened in alcohol, then sectioned and mounted in glycerin.*

Schiefferdecker's Method of Imbedding in Celloidin.—Schiefferdecker † uses two solutions, one of syrupy consistency, the other somewhat thinner. The celloidin plate is cut into small pieces and dissolved in absolute alcohol and ether (in equal parts). Objects are transferred from absolute alcohol,‡ first to the thinner solution, then to the thicker. After remaining a few hours (or days, according to the character of the object) in the latter, they are imbedded in paper boxes. As soon as a hardened film forms on the solution in the box, the whole is placed in 82 per cent. alcohol for 24–28 hours, and thus rendered sufficiently hard for cutting.

Blochmann recommends imbedding on a cork rather than in a paper box, as less celloidin is required, and as the cork is held more firmly in the holder. One end of the cork is made rough and surrounded by a strip of paper, which is made fast by a pin as shown in fig. 137. The roughened surface of the cork is wet with absolute alcohol, and then the object is imbedded in the usual manner. In order that this small box may sink in alcohol, in which it is placed for hardening the celloidin, it may be weighted with a small lead ball fastened to the cork by a needle.

Fig. 137.

In cutting, the knife is kept wet with alcohol (70 per cent.). The sections may be placed in water or in alcohol and afterwards stained with carmine or hæmatoxylin, in which the celloidin is only a little or not at all stained. Anilin dyes colour the celloidin, and therefore should not be used.

The sections can be mounted in glycerin or in balsam, but in the latter case they must be anhydrated with 95 per cent. alcohol, as absolute alcohol dissolves the celloidin. They should be clarified in bergamot-oil or origanum-oil (clove-oil dissolves the celloidin).

Objects imbedded in celloidin can be preserved ready for cutting for a long time in 70–80 per cent. alcohol.

Imbedding in Paraffin.—The object is transferred from absolute alcohol to chloroform, and left till the alcohol has been entirely replaced; it is next placed in a shallow vessel with a small quantity of chloroform and enough paraffin added in fine pieces to cover it

* This method was recommended by Kaiser, Bot. Centralbl., i. (1880) p. 25.

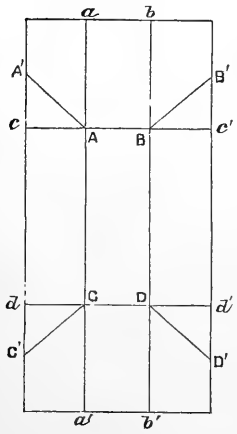
† Arch. f. Anat. u. Physiol. 1882, p. 199.

‡ If the objects are penetrated with difficulty they may be transferred from absolute alcohol to ether, then to the celloidin solution.

after the chloroform has evaporated. The vessel is then exposed to a temperature which corresponds to the melting point of the paraffin employed. The paraffin melts and the chloroform evaporates, so that the object is brought very gradually into pure melted paraffin. In this way the object becomes *completely* saturated with the paraffin.

It is essential that the mixture be kept at the proper temperature until *all* the chloroform has evaporated. A simple test is to place a hot wire in the paraffin, if no bubbles arise it is safe to conclude that the chloroform has entirely escaped.

Fig. 138.



After evaporation of the chloroform the object may be placed in any desired position, and the paraffin allowed to cool. After cooling the object can be cut out and fixed to a larger block of paraffin fitted for the holder of the microtome.

Boxes for imbedding may be made of rectangular pieces of paper, of the thickness of postal cards, in the following manner. The paper is first broken in the lines *a a'* and *b b'* (fig. 138), then *c c'* and *d d'* (by bending always towards the same side). Then in every corner a break (A A' B B' C C' D D') is made by bringing A *c* and A *a* together. The four sides of the box are next bent up, and the corners at the same time turned outwards and back behind the ends A B, *a b*, and C D *a' b'*. Finally the upper edge of these ends is bent down over the corners.

Bubbles around the object may be removed by means of a heated wire.

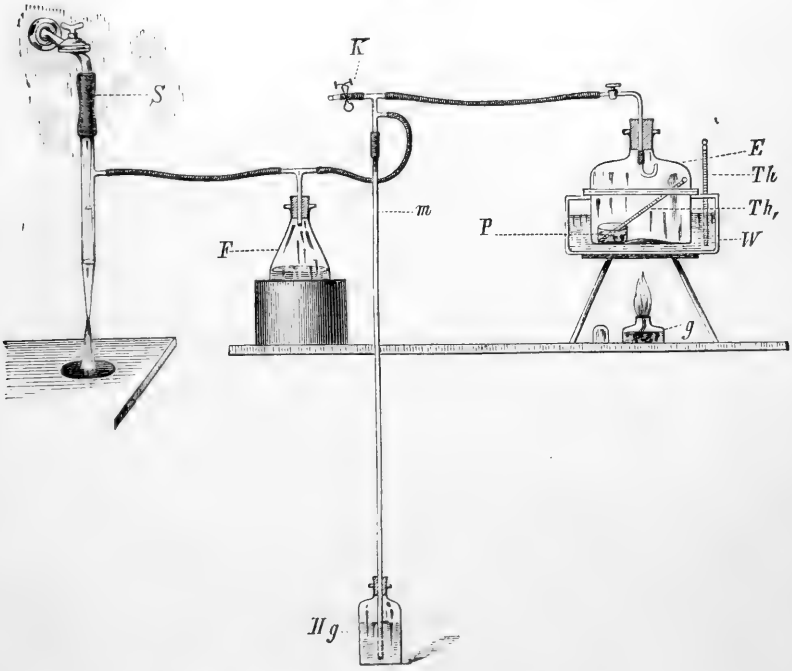
Hoffmann's Imbedding Apparatus.*—Dr. F. W. Hoffmann describes the apparatus he has devised for the more accurate imbedding of anatomical preparations, in which an air-pump is replaced by a suction-pump in connection with a water supply of sufficient pressure.

The suction pump S, which ought to have as free a discharge as possible, is connected with the exsiccator E by means of a strong non-compressible indiarubber tube (or one with a glass tube inside it). The exsiccator contains a few small bowls P, filled with paraffin. The whole is placed in a zinc vessel W, filled with water, and so arranged that the temperature remains constant. Between S and E is the flask F (with strong sides), which is connected with the indiarubber tube by a T piece. A glass tube *m* passes into a bottle of mercury *Hg*, and serves as a manometer. The object of the flask is to prevent the entrance of the water into E in case of any difference of pressure in the pipes. The manometer enables the pressure to be read directly, and enables one to judge whether the preparations are sufficiently penetrated with paraffin.

* Zool. Anzeig., vii. (1884) pp. 230–2 (1 fig.).

In using the apparatus, first heat the water-bath in which E is placed to a temperature of 60° C., then put the bowls containing the melted paraffin and the preparations to be imbedded into E and turn on the water. The two thermometers *Th* and *Th*, record the temperature in W and in the bowl P. The spirit- or gas-lamp *g* should be regulated so that the paraffin does not harden. When the mercury is at the highest point and no more air-bubbles form on the preparation, then the process is finished, and the air may be allowed to enter through K. Before this is done, however, the cock on the vessel E can be closed, so as to leave the preparation still longer in

Fig. 139.



the vacuum. The cock can then be carefully opened and the air allowed to enter. The small bent tube is for the purpose of preventing the scattering of the paraffin by the entrance of the air. Finally the object is taken out and put in a little box filled with liquid paraffin. With sufficient pressure (700–720 mm. *Hg*) every preparation, be it ever so difficult, provided that it is not too large, will be penetrated by the paraffin in about twenty minutes, so that a longer stay in the vacuum is only exceptionally necessary.

Preparations may be left imbedded in this way for weeks in the open air with unprotected cut surfaces without their undergoing any

change. As in other methods, the water must be previously entirely removed from the preparation, and then it is quite unimportant whether before putting it into paraffin it is placed in turpentine oil or oil of cloves, or, as the author does, into resinous turpentine saturated with paraffin, which must not be too thick.

Celloidin for Imbedding.*—The following is the manner of preparing and using this material practised in the laboratory of the Alumni Association of the College of Physicians and Surgeons at New York (as given by Dr. G. C. Freeborn).

A saturated solution of celloidin is made in a mixture of equal parts of ether and 97 per cent. alcohol. This requires about 24 hours with occasional agitation. The object to be imbedded is soaked in a mixture of ether and alcohol for some time, then transferred to the imbedding fluid and allowed to remain overnight.

One of two ways of imbedding may be adopted:—

1. Cover the smooth surface of a cork with a thick layer of celloidin solution and allow it to dry; place the specimen, which has previously been soaked in the imbedding fluid, on this, and cover it, layer by layer, with a solution of celloidin, allowing each layer to partially dry before applying another. When the specimen is completely covered immerse in alcohol of 80 per cent. for twenty-four hours when it will be ready to cut.

2. The specimens are imbedded in paper boxes in the usual way, or a cork is wrapped with one or two layers of thick writing paper, allowing it to project an inch or an inch and a half above the surface of the cork. By this procedure a round box with the cork for a bottom is obtained. Into this box pour a small quantity of the imbedding fluid, and allow it to dry. The specimen having been previously soaked in the celloidin solution, is now placed in the box, adjusted as to position and allowed to dry for five or ten minutes, so as to fix it; the box is now filled with the imbedding fluid. The boxes are exposed to the air until the imbedding mass has become semi-solid, and are then immersed in weak alcohol (alcohol 95 per cent. two parts, water one part) for twenty-four hours, when the specimen will be ready for cutting. If the specimen has been imbedded in a paper box and sections are to be cut with a sliding microtome, it is necessary to mount it on a cork. This is accomplished in the following manner:—Cover the surface of a smooth cork with a thick layer of celloidin solution, allow it to dry, and again cover with the same. Trim off the superfluous imbedding mass from around the specimen, cut the lower surface even, wet it with a drop or two of ether, and adapt it to the layer of celloidin on the cork. Dry for a few moments and place in dilute alcohol for a few hours, when the specimen will be ready for cutting. If the plan of imbedding in the boxes with a cork for the bottom is adopted, the specimen is imbedded and mounted on the cork at the same time.

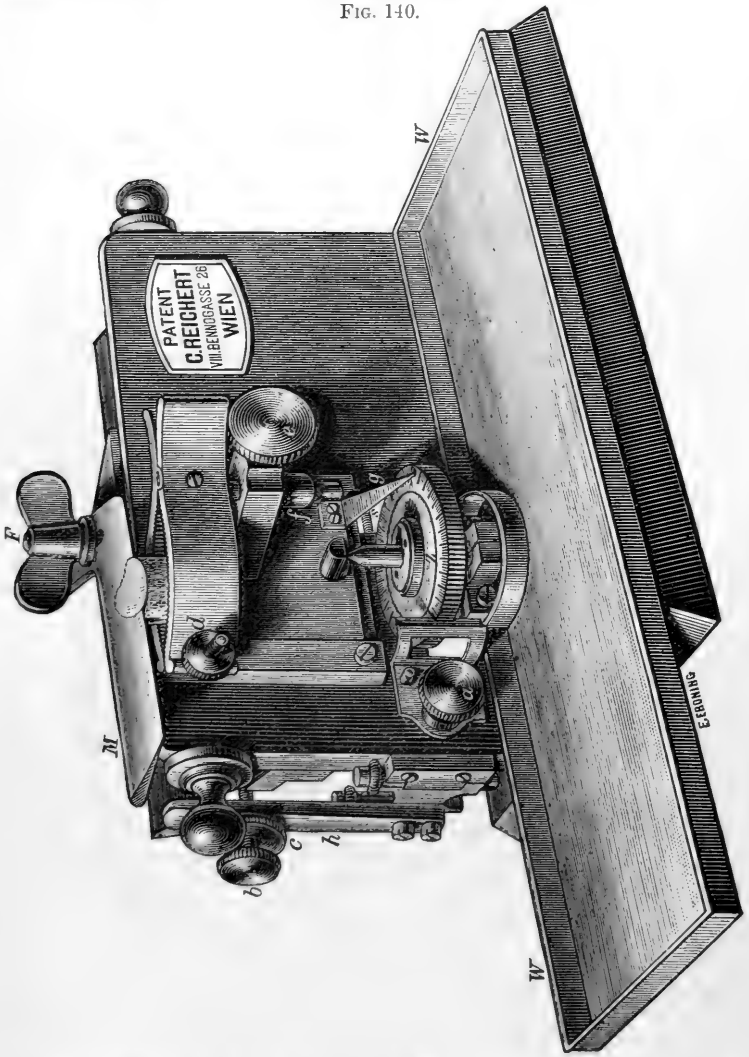
Sections may be stained with the different staining fluids and mounted in glycerine or other media. If mounted in Canada balsam

* Amer. Mon. Micr. Journ., v. (1884) pp. 127–8, from New York Med. Journ.

and the specimen is to be retained in the imbedding mass, absolute alcohol for dehydrating and oil of cloves for clearing are to be discarded, for they both dissolve the celloidin, and alcohol of 96 per cent. and oil of bergamot, oil of sanders, or oil of origanum used.

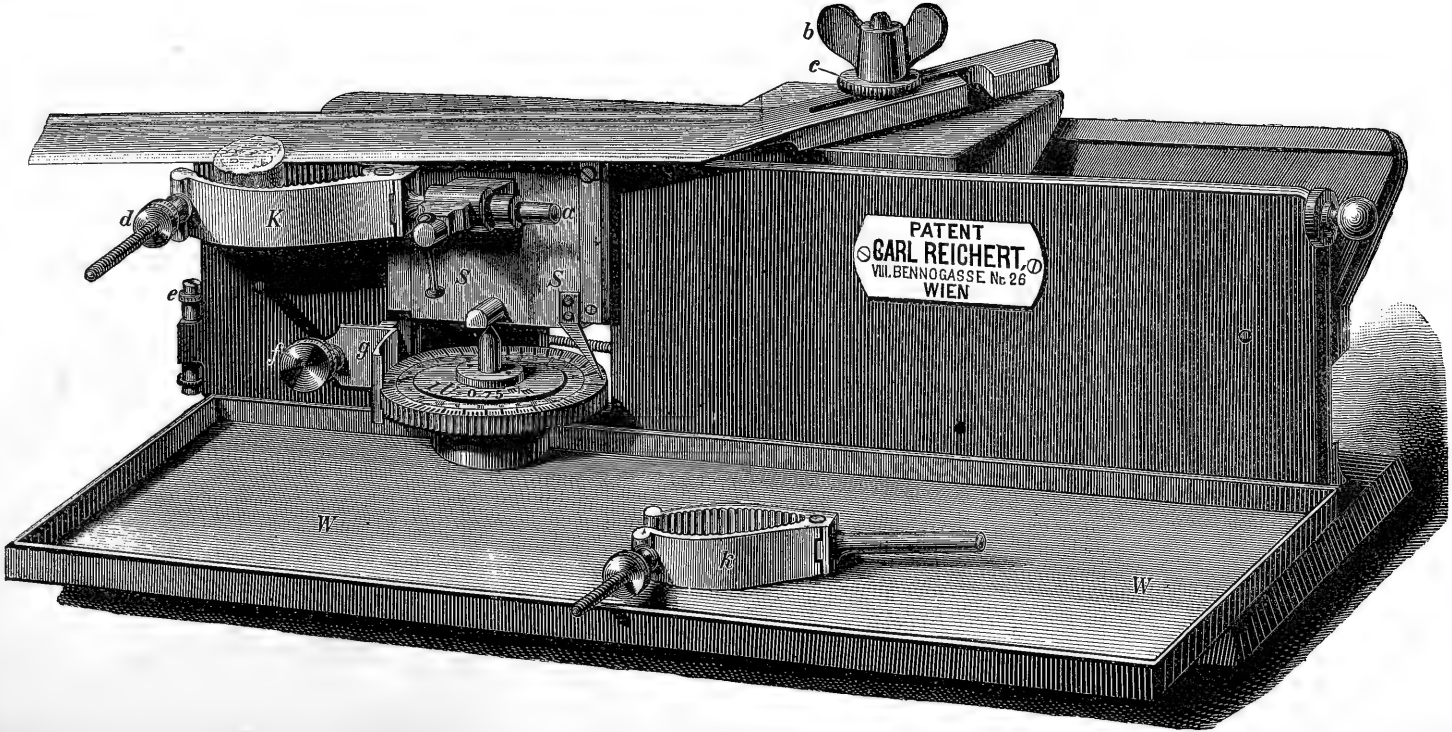
Reichert's Microtomes.—The essential feature of these Microtomes is that the object is automatically raised.

FIG. 140.



The carrier, to which the knife **M** is attached by the screw **F**, rests on six points, for greater exactness and for reducing friction.

Fig. 141.

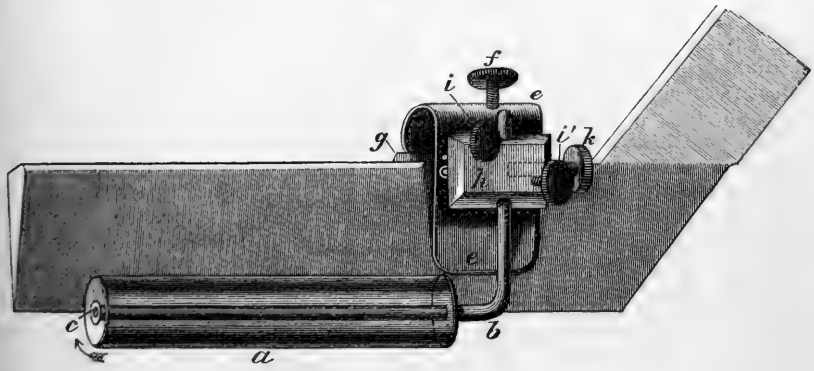

b
c
d
K
a
S
S
e
f
g
W
W
PATENT
CARL REICHERT
VIII. BENNOGASSE No 26
WIEN

The vertical axis of the toothed wheel *z* on the top of which the object-carrier rests, ends below in a screw with a pitch of 0·75 mm. The knife-carrier at each cut pushes against the lever *h*, the horizontal arm of which catches in the wheel *z*, which has 100 teeth. At the commencement of each cut a spring *s* draws the lever back ready for the cut. The lever is regulated by *b c*, so that it will move the wheel *z* only one tooth forward or several teeth up to ten. The wheel is prevented from moving backwards by a catch attached to *a*. Sections of 0·0075–0·075 mm. can thus be cut. If sections thicker than 0·075 mm. are required the automatic apparatus is detached, the catch at *a* being removed and the spring *s* detached. The thickness of the section is now indicated by the pointer *g* and the graduations on the periphery of the wheel. So that the knife may not inadvertently cut against the object-carrier a contrivance is added which prevents the lever working in the wheel after a given height has been reached. The axis *f* of the object-clamp is fixed by the screw *e*, so that it can be raised or lowered. The jaws can be brought closer together by *d*. The tray W serves for catching spirit, &c.*

The instrument fig. 141 is a larger form of the previous instrument, 38 cm. long instead of 20 cm.

Decker's Section-smoother.†—Dr. F. Decker describes the apparatus shown in fig. 142. The essential principle consists in the application to the knife-blade of a glass cylinder *a*, which can rotate on an axis *b c*.

Fig. 142.

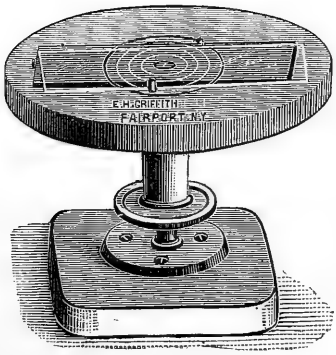


The knife has attached to it a steel bow *e e*. By turning the screw *f*, which acts on a long steel plate *g*, the bow is made to grip the knife tighter. The block *h* is attached by a hinge to *e* (its axis

* Cf. Zeitschr. f. Wiss. Mikr., i. (1884) pp. 241–4 (1 fig.).
† Arch. f. Mikr. Anat., xxiii. (1884) pp. 537–43.

being parallel to the knife-blade), and the bent arm of the axis of the glass cylinder passes into it and is clamped by the screw *k*. By the screws *i* and *i'* the block *h* can be raised at one end and depressed at the other, thereby raising or lowering the cylinder *a* above the knife-blade. The maximum length suggested for the cylinders is 5 cm. and the diameter 4, 6, and 9 mm.

Fig. 143.



Griffith's Turntable. — Mr. E. H. Griffith has devised the ingeniously simple turntable shown in fig. 143.

The centre of the table, marked with the circles, has a spiral spring attached to it beneath. The slide being placed between the two pins in this centre, is partially rotated against the spring and pushed forward, when the spring keys it between the two pins and a third fixed pin at the upper side of the slide (towards the left). The fourth pin, at the left end, is for length. The table rotates on a pointed spindle, and can be lifted off it as required.

Reversible Mounts.*—Of late years much attention has been given to the preparation of whole insects, without subjecting them to pressure, by using cells of vulcanite or other suitable substance affixed to the ordinary slides. T. J. Briant has in the same way put up *thick sections* of various parts of insects with very good results. Such preparations allow of the examination of the various parts as they are arranged in the body of the insect, and are comparatively easy to make, either by the ordinary section-cutter or by hand. It is, however, frequently found, both in the case of whole insects as well as that of the thick sections, that one wants to know the appearance from the opposite side. Of course the slide may be turned over, but the critical examination of an object through glass of the thickness of an ordinary slip is very difficult—practically impossible.

In order to overcome this difficulty take a vulcanite ring and fasten a thin cover as a bottom to it with any good cement; fill it with balsam, immerse the preparation, and cover with another thin cover. Then put this aside to dry, placing it on the top of a small cork fixed in a bottle, and thus preventing the superfluous balsam fastening the ring to the shelf or table. The ring with its cover and contents is then placed in a wooden slide, with a hole corresponding in size to that of the ring. Usually there is enough balsam around the edge to hold the ring in place, but if not the slip may be covered on both sides with paper. In the case of small objects, two glass covers may be used, kept apart by small pieces of thin glass cover;

* Thirteenth Ann. Rep. South London Micr. and Nat. Hist. Club, 1884, p. 13.

these can be fastened in the wooden slips by covering one side with paper, with of course, the necessary hole cut a smaller size than the hole in the wood slip, and while the gum is wet dropping the glass in place; then when dry covering the other side.

Mr. Briant has found immense advantage in being able to reverse the preparation in this way, many difficult points being easily solved upon examining both sides.

Hinman's Device for Mounting.*—G. C. Hinman's device consists of a perforated plate with the edges turned up so as to receive a glass slip, and hold it with the centre over the centre of the perforation, thus enabling the object to be placed centrally without difficulty. When the object is mounted this plate is placed upon another under a spring having three points in a plane parallel with the surface of the slip, which can be pressed down upon the cover-glass with any desired force, and thus bring the cover-glass into a plane parallel with the slip.

Mr. J. H. Pillsbury considers this by far the most convenient instrument for holding the cover-glass in place which he has ever seen.

Preparing Schultze's Solution.†—Prof. W. Hillhouse describes the following method of preparing Schultze's solution, a modification of that of Radlkofer. Pure granulated zinc is dissolved in hydrochloric acid at an ordinary temperature; the solution is evaporated at a temperature of about 70° or 80° C. and under contact with metallic zinc, to a syrup which does not get muddy on addition of much water, and has the specific gravity 2·0 This syrup is poured off and diluted with water to specific gravity 1·8—that is, twelve parts of water are added to every hundred of the syrup. In 100 parts of the resulting fluid dissolve at a gentle heat six parts of potassium iodide, and then dissolve in the whole as much iodine as it will take up. The solution will now have the consistence of concentrated sulphuric acid, is perfectly clear, of a bright golden-brown colour, slowly becoming somewhat darker on exposure to light. It can be brought to various degrees of dilution, as its action varies according to the strength. It is best kept in the dark.

Styrax and Liquidambar.‡—Dr. H. van Heurck has a further note on these substances, in which, after referring to the commendations of Cole, Dippel, Grunow, and Kitton, he quotes that of Strasburger in his 'Das Botanische Practicum,' who recommends it for making visible the details of the nucleus of plant-cells previously stained with hæmatoxylin. The cytoplasm is invisible, while the details of the nucleus are seen with the greatest clearness.

A "new quality" of styrax Dr. van Heurck finds to be, as mentioned *ante* p. 655, that instead of becoming coloured by time and

* Amer. Mon. Micr. Journ., v. (1884) p. 140.
† Proc. Camb. Phil. Soc., iv. (1883) p. 399.
‡ Bull. Soc. Belg. Micr., x. (1884) pp. 178–82.

light like Canada balsam, the preparation becomes absolutely colourless.

The solution should be used as follows:—Place the cover-glasses on a large glass plate, and put on each by a pipette a large drop of distilled water, and on this let fall gently a drop of the liquid containing the diatoms. Then cover them with a watch-glass and allow to evaporate spontaneously. When this is done the cover-glasses are separately heated to redness on platinum and transferred to the glass plate, and a drop of a very fluid solution of styrax or liquidambar put on them and the watch-glass replaced. In twenty-four hours the benzine is completely evaporated. The cover-glass is then put on the slide and slightly heated, preferably in a water-bath. A light pressure will drive out air-bubbles.

Preparing Shellac Cement.*—R. Hitchcock gives an easy method of preparing an excellent clear solution of shellac.

Obtain from a paint-shop a quantity of shellac spirit-varnish, or prepare it by dissolving common shellac in alcohol. It is well to use five or six ounces of the varnish, as there will be considerable shrinkage in volume during the process. Place the varnish in a bottle, which it should not more than two-thirds fill, and add to it about one-quarter of its volume of naphtha or "petroleum spirit." Put in the cork and shake well, to thoroughly mix the two liquids. Let the mixture stand a few minutes and shake it again, repeating the operation two or three times. Then let the bottle stand undisturbed for twelve hours, or as much longer as convenient. The naphtha will be found in a layer above the shellac containing the flocculent matter, which, being insoluble in cold alcohol, renders the ordinary solutions of shellac turbid, while the alcoholic solution beneath will be perfectly clear. By means of a siphon, extemporized by a rubber or glass tube, the clear shellac may be drawn off from beneath the naphtha.

The solution thus obtained will be too thin for microscopical use. It should therefore be placed in an evaporating dish and heated very gently—preferably over a water-bath in which the water is not allowed to boil—until it reaches a syrupy consistence. When cold it will be thicker than while warm, and it should be tested by placing a few drops on a cold slide and watching its behaviour. When it seems to be right the solution may be poured into a bottle and about three drops of castor-oil added for every ounce of solution. This causes it to flow smoothly from the brush.

In practice we have found it advisable to evaporate the solution, as above described, until it is too thick to flow from the brush, and then to thin it with strong alcohol. The reason is that during evaporation the alcohol of the original solution is driven off more rapidly than the water that is associated with it. Therefore, by the time the solution is reduced to one-fourth its original volume the alcohol has become much weaker than it should be, and the cement

* Amer. Mon. Micr. Journ., v. (1884) pp. 131-2.

dries slowly. By thinning the solution with strong alcohol the resulting cement becomes all that can be desired.

It is well to have two kinds of shellac cement always at hand—one so thick that it will just flow from the brush on the turntable, the other thinner. The first is useful for making cells, the second as a general cement to attach covers, &c.

Coating Diatoms with Silver.*—A. Y. Moore burns one side of a diatom to the cover-glass and then coats the other side with pure silver. The refractive index of silver according to Brewster is 3·27, and the visibility of a diatom so prepared is four times as great as when mounted dry, or more correctly, in the proportion of 1·84 to ·43. "The results obtained by giving such a visibility to the diatom and at the same time utilizing the full aperture of the objective, can hardly be imagined by one who has never seen it. The dots upon *Amphipleura pellucida* are shown in a way which would readily convince those who still deny their existence. Even *Rhizosolenia alata* yields transverse lines which, so far as I know, have never been seen by any other method."

Lyon's Mailing Case.†—H. N. Lyon takes two slips of wood 3 by 1 in. and 1/16 in. thick, and in the centre of one makes a hole a little larger than the cell. Paste a piece of stiff paper on one side of this slip, covering the hole. Lay the slide between the slips and along one side paste a piece of paper, not touching the glass slide however. A rubber band holds the package tight, and it may be sent as it is or first wrapped in paper. If two or more slides are to be sent the modus operandi is the same, except that the openings are alternately on opposite sides. In this case the middle slips need not be covered.

Action of Reagents in the discrimination of Vegetable Fibres.‡—V. Berthold classifies the more important vegetable fibres according to the action upon them of iodine and sulphuric acid, as follows:—

A. Coloured blue, violet, or green by iodine and sulphuric acid:—Flax, Chinese grass and ramie (*Boehmeria nivea*), roa (*Pipturus argenteus*), cotton, hemp, and sunn-hemp (*Crotalaria juncea*).

I. Transverse sections coloured blue or violet, but showing no yellow middle lamella; cell-cavity usually filled with a yellow mass.

a. Flax. Transverse sections occur either isolated or a small number in a group; the separate transverse sections are not contiguous; they are polygonal, bounded by straight lines, and have sharp edges. Lamination evident, blue or yellow; cell-cavity a yellow dot. Longitudinal distortions of the striæ indicated by darker lines which usually cross.

* The Microscope, iv. (1884) pp. 157–9 and 165.

† Ibid., p. 179.

‡ Zeitschr. f. Warenkunde, 1883, pp. 14–5, 17–8 (16 figs.). See Bot. Centralbl., xvi. (1883) p. 308.

b. Chinese grass and Ramie. Transverse sections isolated or a small number in a group; their connection very loose; they are polygonal or irregular, and very large. Lamination very evident; cell-cavity large and irregular, often filled with dark yellow masses; sometimes striated radially. In the longitudinal aspect some fibres appear very broad, but their breadth is very variable; distortions evident; the ends thickly rounded.

c. Roa-fibre. Transverse sections not many in a group, polyhedral, usually with straight or slightly curved sides and rounded edges; cell-cavity narrowly oblong, regular; contents sometimes yellow. Some transverse sections are surrounded by a thin greenish lamella, and show well-marked radial striæ or fissures and connective lamination; the separate lamellæ vary in depth of colour.

d. Cotton. Transverse sections always isolated, rounded, of various forms, usually reniform; cell-cavity narrow, linear, contents usually yellow. No lamination.

II. Transverse sections blue or violet, polyhedral, rounded or irregular, always surrounded by a yellow middle lamella.

a. Hemp. Transverse sections always in groups, contiguous, with rounded edges, surrounded by a thin yellow middle lamella, beautifully laminated concentrically; cell-cavity linear, simple or branched, irregular, sometimes broad, without contents.

b. Sunn-hemp. Transverse sections numerous in a group, closely contiguous, resembling hemp, often sickle-shaped, either polygonal or oval, with a small round cell-cavity, often with yellow contents. Surrounded by a broad yellow middle lamella, from which the inner laminæ are often detached.

B. Coloured yellow by iodine and sulphuric acid.

I. Dicotyledons. No vessels besides the bast-fibres; cell-cavity with constrictions.

1. Transverse sections in groups, polygonal, bounded by straight lines, with sharp edges; cell-cavity round or oval, smooth, empty, surrounded by a narrow middle lamella of the same colour.

a. Jute. Cell-cavity large, roundish, oval; middle lamella very narrow; no lamination; the ends always rounded, and almost always strongly thickened.

b. Abelmoschus. Transverse sections larger than *a*, bounded by straight lines, sharp-edged; cell-cavity a dot or line, oval, rarely angular, smaller than *a*. Fibres of uniform thickness; ends broad, rounded, often thickened; cell-cavity variable, often reduced to a line.

2. Transverse sections always in groups, polygonal, bounded by straight lines, with sharp or slightly rounded edges; cell-cavity empty. Middle lamella broad and decidedly

darker than the transverse sections; cell-cavity with constrictions, locally entirely absent.

a. Hibiscus. Edges sharp or rounded; in the first case the cell-cavity small, in the latter case broader and oval; middle lamella sometimes wanting; transverse sections only slightly and inconspicuously laminated. Fibres of very various thickness, not usually striated longitudinally; ends rounded, blunt and almost always thickened

b. Urena sinuata. Edges sharp; cell-cavity very small, a dot or narrow short line; middle lamella broad and very distinct; transverse sections not laminated. Fibres of uniform thickness; rarely striated longitudinally; ends rounded, rarely somewhat thickened.

II. Monocotyledons. Vessels in addition to bast-fibres; cell-cavity without constrictions.

1. Transverse sections usually rounded, rarely polygonal; cell-cavity always round; no middle lamellæ.

a. New Zealand Flax (Phormium tenax). Transverse sections small, usually round, closely contiguous, polygonal with rounded edges; cell-cavity empty. Fibres thin, uniform, smooth, rigid; cell-cavity small, of uniform breadth, without striation or distortion; ends sharp.

b. Manila Hemp (Musa textilis). Transverse sections polygonal with rounded edges, or roundish; cell-cavity large, roundish, sometimes with yellow contents. Fibres of uniform thickness, smooth, not striated; walls thin; ends sharp, or slightly rounded. After combustion siliceous skeletons remain behind in the form of strings.

2. Transverse sections evidently polygonal; cell-cavity polygonal, with one or more sharp edges, moderately large; no middle lamella.

a. African Hemp (Sanseviera). Transverse sections closely contiguous, not laminated. Fibres thin, smooth, with sharp ends.

b. Aloe. Transverse sections not very numerous in a group; edges slightly rounded; cell-cavity not very large, polygonal, often with rounded ends; large spiral vessels; fibres of uniform thickness, without structure; ends sharp or rounded.

c. Agave. Transverse sections polygonal, bounded by straight lines, closely contiguous; cell-cavity large, polygonal; its edges less sharp. Fibres rigid, considerably broader towards the middle; ends broad, thickened, sometimes split.

3. Transverse sections polygonal, closely contiguous, small, bounded by straight lines; edges very sharp; cell-cavity small, round or linear; middle lamella very evident. Fibres narrow, striated, with sharp ends:—*Yucca.*

Reagents for Tannins in Vegetable Cells.*—W. Gardiner specifies objections to all the micro-chemical reagents for tannins hitherto used. Iron sulphate he finds convenient when the products are blue and not green. He prefers to use a solution of ammonium molybdate in concentrated ammonium chloride; this gives with tannins a copious yellow precipitate. It can also be used for determining the presence of gallic acid, with which it produces only a red colour; the compound with gallic acid is soluble in ammonium chloride, while that with tannin is not.

The determination of tannins in tissues preserved in alcohol is facilitated by the fact that dead protoplasm gives a permanent precipitate with tannins.

The author regards the tannins as secondary products of metastasis, especially when this process is very active, and thinks that they have no further use. In the old leaves of a cutting of the cherry-laurel which had already put out roots and shoots, the quantity of tannin had considerably increased.

Microscopical Examination of Chestnut-meal.†—T. F. Hanausek gives the following microscopical characteristics of the various parts of the sweet chestnut. The testa of the chestnut consists of three layers. The cells of the outermost layer are polyhedral thick-walled plates with yellow or dark-brown angular flakes (tannin?). Many bear stiff cylindrical unicellular hairs, varying in thickness from 0·018 to 0·029 mm., and of variable length. Some have thin and others very thick walls; the former contain tannin. The middle layer is composed of tangentially elongated, thin-walled, bright-red parenchymatous cells, which swell up in potash to a broad elliptic form, and are coloured of a beautiful violet-blue by chloride of iron. It has also strong vascular bundles and large cavities. The innermost fibrous layer forms a narrow light-brown streak composed of thin-walled fibrous elements.

The two cotyledons consist of an amylaceous parenchyma. The outermost layer of cells are narrow five- or six-sided radially arranged prisms, with a diameter of 0·007–0·01 mm.; in the radial direction they are three or four times as long. The very small colourless protein-grains are only coloured pale yellow by iodine, on account of the envelope of oil which surrounds them. The amylaceous cells have a diameter from 0·055–0·075 mm., and contain, besides starch, a parietal layer of albuminoids and oil. The starch-grains are sometimes simple, sometimes double. The simple grains are extremely variable in form; the most characteristic forms are triangular, and one has an acute projecting appendage. Some resemble the cap-shaped partial grains of tapioca. The nucleus is central and difficult to detect; stratification is indicated in the largest by two or three inconspicuous lines. The polarization-cross is very conspicuous. The smaller spherical or ellipsoidal grains have a diameter of from 0·005–0·009 mm.; the

* Proc. Camb. Phil. Soc., iv. (1883) pp. 387–94.

† Zeitschr. f. Landwirtschaft. Gewerbe, 1883, pp. 3–5 (3 pls.). See Bot. Centralbl., xiv. (1883) p. 180.

largest observed measured 0·025 mm. in length and 0·016 mm. in breadth; the most common length was about 0·02 mm.

Microscopical Investigation of Dyed Cotton Fabrics.*—R. Meyer finds that cotton goods which have been dyed by means of the albumin process can easily be distinguished from articles which have been printed with soluble dyes, by means of the Microscope. For example, if a piece of cotton is first treated with a solution of lead acetate, and afterwards with a chromate, the fibres are uniformly coloured. But if the goods have been printed with a mixture of precipitated lead chromate and albumin, and the colour fixed by steaming, the fibres themselves appear colourless under the Microscope, but patches of coloured albumen are attached to the fibre.

Microscopical Examination of Water for Organic Impurities.†—J. Brautlecht produces a precipitate in the water by adding to 100 cc. 5 drops of a solution consisting of 1 part aluminium sulphate, 1 part hydrochloric acid, and 8 parts water, followed up by one to three drops of liquid ammonia. The precipitate settles readily, and after decanting off the clear solution, is collected upon a smooth filter, stroked off with a glass rod, and thus transferred to a test-tube, in which it is dissolved in ten to fifteen drops of dilute acetic acid. The clear solution is examined with the Microscope, at first alone, and then after the addition of a solution of saffranine. By adding one-half per cent. of gelatine permanent preparations may be obtained on Koch's principle.

A. Certes‡ summarizes in a very convenient form the procedure necessary for an effective microscopical examination of water. The more general observations of the first sixteen pages are followed by eleven of practical instructions, in which are dealt with the collection of the water, the employment of reagents and their formulæ, preservative liquids, colouring matters, &c.

For the ordinary examination of microbia the power ought not to be less than 250 or 300. For more extended study, powers of 700 to 800 are necessary.

"The use of staining reagents ought never to be neglected after direct examination, as they define much more distinctly the colours and certain details of structure, such as the vibratile cilia, flagella, nuclei, and nucleoli of the ciliate or flagellate infusoria. Especially important is the part which staining reagents will certainly play in the future in regard to the different elements of the protoplasm.§

* Journ. Chem. Soc.—Abstr., xliv. (1883) p. 751. Ber. Deutsch. Chem. Gesell., xvi. pp. 455–7.

† Rep. Anal. Chemie und Chem. Zeitung. Cf. Chemical News, xlviii. (1883) p. 180.

‡ Certes, A., 'Analyse micrographique des Eaux,' 8vo, Paris, 1883, 28 pp. and 2 pls.

§ The various colouring substances give very different reactions, according to the organisms with which they are brought in contact. Manufactured for the most part for commercial purposes, they are far from being homogeneous. Still more rarely are they chemically pure. Hence arise mistakes and uncertainty in their use.

Some organisms, morphologically alike so far as appears with our present means of investigation, behave very differently with the same staining agents. The chemical affinities are not always the same during life and after death, and there seems to be some relation between the diversity of constitution of the protoplasm, revealed to us by the diversity of the reactions, and the physiological or pathogenic *rôle* of certain microbia. In other terms, where there are no morphological species, reagents like inoculations show us distinct physiological species.

Is it not remarkable, for instance, that dahlia violet, methyl blue, and iodine green, which, managed carefully, only colour the nucleus of living infusoria, also colour, but always entirely, a great number of rods and bacterian filaments? We are thus led to consider the chromatic elements of the protoplasm as diffused in the microbia, whilst they are differentiated and condensed under the form of nucleus or nucleolus in the infusoria properly so called.

If, on the other hand, we consider that in the cells and infusoria the transformations of the nucleus and nucleolus always precede the phenomena of reproduction, however much they differ, and that generally these transformations largely modify the form of the nucleus and nucleolus, we are less surprised to see the same bacterian rod in process of development pass, as Cienkowski has shown, through phases corresponding with the very distinct forms from which morphological species have been made."

Dr. J. D. Macdonald has also issued a second edition of his 'Guide to the Microscopical Examination of Drinking Water,' in which he gives the following directions for collecting and examining sediments:—

When water is very turbid, from an obviously impure source, it is easy enough to obtain a sufficient amount of sedimentary matter for microscopical examination, and a just estimate of the unfitness of such water for drinking purposes may be thus readily formed. But it more frequently happens that the deposit, even after long standing, is but slight, and when this is the case, we must have recourse to special means, by which the whole or a large amount of the matters in suspension may be concentrated or collected together within a small compass. In the first place one of the tall glass vessels above described, should be filled with the water to be examined, and a circular disk of glass, resting on a horizontal loop at the end of a long aluminium wire lowered to the bottom, when the whole arrangement, lightly covered, must be set aside for 24 or 48 hours, as the case may be.

At the end of the specified time, the water should be siphoned off with a piece of indiarubber tubing, so as to leave only a thin stratum of the liquid over the glass disk. This should now be carefully raised and laid upon blotting-paper to dry its under surface and remove the surplus moisture, when it may be at once transferred to the Microscope, with a large piece of cover-glass so placed upon it as to exclude all air-bubbles. An ordinary watch-glass may in some cases be substituted for the disk alluded to, with advantage, as being less likely to permit the loss of sediment by overflow, which is certain to happen

with a plane surface. The operator must be cautioned not to use iron wire, which rusts so rapidly that it will soon throw down a flocculent precipitate. Another good plan, which is perhaps the better of the two, is to siphon off the water until only a sufficient quantity remains to permit the sediment to be shaken up with it, and poured into a tall conical glass, from which, after standing again for a short time, portions may be taken up by means of a pipette, and placed on slides for examination. If the subsidence is observed to be complete, it is rather an advantage to have a good body of water in the glass, or, at least, so much as will permit the pipette to be used with ease and facility. It may be observed here, that it is very inconvenient to have too much fluid at a time on a slide. The cover-glass will be unstable and liable to have its upper surface wetted, while the objects themselves will be tremulous, if they do not quite run out of the field. To obviate this, the pipette, when taken out of the water, should be held in a vertical position for some little time, until the suspended matters gravitate to the bottom of the tube, when a well-charged droplet might be placed on a number of separate slides and examined seriatim. This is, in fact, the only way in which a large sediment can be thoroughly inspected.

M. Balland also gives* a neat and easy method for examining water contaminated by the drainage of cesspools. Into a long tube he pours a few cubic centimetres of a solution of sodium hypobromide, and then fills it completely with the water to be examined. Placing the thumb on the tube, it is inverted and placed in a glass containing mercury. If urea is present, bubbles of nitrogen gradually rise in the tube and collect at the closed end.

J. W. Mallet describes† apparatus whereby the water to be examined may be evaporated under greatly reduced pressure and at a correspondingly low temperature, out of contact with the air. Under such conditions, the organic matter is altered much less than in the apparatus generally made use of. As test-materials, leucine and tyrosine were selected, as representing the more stable products of putrefaction liable to occur in natural water, and for which the combustion process in its natural form had been found to give results far from satisfactory.

Mr. G. E. Davis has also published‡ two articles on 'Water, Water Analysis and the Microscope.'

Changing the Water in Aquaria containing Microscopical Organisms.§—F. Könike describes the following as the more convenient way for emptying aquaria without drawing away the minute organisms :—

Tie over a small flask or glass, with the widest possible mouth, a piece of fine muslin in such a manner as not to stretch it tight. Then put the end of an indiarubber tube through the middle of the muslin to the bottom of the glass. At the place through

* Journ. de Pharm. et de Chimie, 1883. Cf. 'Athenæum,' 24th Nov., 1883.
† Chem. News, xlvii. (1883) pp. 218–20, 232–3.
‡ Micr. News, iii. (1883) pp. 309–13 (7 figs.).
§ Zool. Anzeig., vi. (1883) pp. 638–9.

which the tube passes, fasten the muslin tightly with thread to the tube, and sink the glass to the bottom of the aquarium. On exhausting the tube the glass will fill with water, and the aquarium will in this way be emptied, the water passing through the muslin. If a stoppage should occur the cause will in most cases be some dirt having settled on the muslin. It is for this reason that a glass with a wide mouth is recommended.

Micro-chemical Test for Sodium.*—A. Streng proposes to employ uranium acetate as a test for sodium; by its action on any sodium solution, crystals of uranium sodium acetate are formed, which are but sparingly soluble in water. They appear in the form of tetrahedra and the minute yellow crystals cannot be mistaken for the rhombic crystals of uranium acetate, which separate out as the solution dries, on account of their action on polarized light. The reaction is very sharp, as the double salt contains a very low percentage of soda (6·6 per cent.).

Micro-chemical Reaction of Solanine.†—J. Schaarschmidt gives the following test for determining the presence of this alkaloid. The section is laid in a drop of nitric acid or of not too concentrated sulphuric acid, covered, and immediately placed under the Microscope. A rose-red colour supervenes after a few seconds, especially if nitric acid be employed. By this method the author found solanine in *Solanum tuberosum*, especially in the sub-peridermal cells of the tuber, and in the sub-epidermal cells of the stem and leaf-stalk; also in the collenchyma of *S. nigrum* and *Dulcamara*, *Capsicum annuum*, *Lycopersicum esculentum*, and *Mandragora officinalis*. The epidermis of the sepals of *Solanum nigrum* is especially rich in solanine.

Size of Atoms.‡—Sir W. Thomson gives an estimate of the size of atoms or molecules, founded on four lines of reasoning—(1) the undulatory theory of light, (2) the phenomena of contact electricity, (3) capillary attraction, and (4) the kinetic theory of gases—which all lead to substantially the same estimate of the dimensions of molecular structure. "Jointly they establish, with what we cannot but regard as a very high degree of probability, the conclusion that, in any ordinary liquid, transparent solid, or seemingly opaque solid, the mean distance between the centres of contiguous molecules is less than the 1-5,000,000th, and greater than the 1-1,000,000,000th of a centimetre.

"To form some conception of the degree of coarse-grainedness indicated by this conclusion, imagine a globe of water or glass, as large as a football, or say a globe of 16 centimetres diameter, to be magnified up to the size of the earth, each constituent molecule being magnified in the same proportion. The magnified structure would be more coarse-grained than a heap of small shot, but probably less coarse-grained than a heap of footballs."

* Jahrb. f. Mineral., ii. (1883) p. 365. See Journ. Chem. Soc.—Abstr., xlv. (1884) pp. 366-7.

† Zeitschr. f. Wiss. Mikroskopie, i. (1884) pp. 61-2.

‡ Proc. Roy. Inst., x. (1883) pp. 185-213 (11 figs.).

In an article on "Liquid Films and Molecular Magnitudes" * A. W. Reinold and A. W. Rücker give the results of their measurements of soap films in the last stage of tenuity, and in which, referring to Sir W. Thomson's lecture, they say: "If the size of the molecules of which the liquid is composed is between 2×10^{-6} and 1×10^{-8} mm. (the limits given by him) it follows that the thinnest film measured by us, which was $7 \cdot 2 \times 10^{-6}$ mm., must contain not less than 3 and not more than 720 molecules in its thickness. The smallness of the smaller of these numbers tends to show that the real size of the molecule is considerably below Sir W. Thomson's superior limit."

B. Sc.—Difficulties in Mounting.
[To avoid air-bubbles in glycerine cell-mounting. — Varnish twice at intervals of a couple of hours with a solution of shellac in alcohol and then finish off with ordinary bitumen.]
Sci.-Gossip, 1884, p. 212.

Baumgarten, P.—Ueber Untersuchungsmethoden zur Unterscheidung von Lepra- und Tuberkel bacillen. (On methods for distinguishing Leprosy and Tubercle Bacilli.) *Zeitschr. f. Wiss. Mikr.*, I. (1884) pp. 367–71.
„ „ Ueber eine gute Färbungsmethode zur Untersuchung von Kerntheilungsfiguren. (On a good staining method for investigating the figures in the division of nuclei.) [*Post.*]
Zeitschr. f. Wiss. Mikr., I. (1884) pp. 415–7.

Beecher, C. E.—A New Design for a Microscope Cabinet. [*Post.*]
Amer. Mon. Micr. Journ., V. (1884) pp. 126–7 (1 fig.).

Bell, J.—The Chemistry of Foods.
[I. Tea, Coffee, Cocoa, Sugar, &c. II. Milk, Butter, Cheese, Cereal foods, &c.] 8vo, London, 1884.

Bonnet, R.—Kurzgefasste Anleitung zur mikroskopischen Untersuchung thierischer Gewebe für Anfänger in der histologischen Technik. (Condensed Guide for the Microscopical Investigation of Animal Tissues for Beginners in Histological Technic.) 8vo, München, 1884, 61 pp. and 2 figs.

Chase's (H. H.) *Amphipleura pellucida* and other test-objects mounted in a medium of refractive index 2·42. *Amer. Mon. Micr. Journ.*, V. (1884) p. 159.

Cole, A. C.—Methods of Microscopical Research. Part XIII. pp. lxxiii.–lxxxiii.
On Photo-micrography. Plate of T. S. Spine of *Echinus* under (4) various conditions of illumination—1 fig.
„ „ Popular Microscopical Studies. No. XII. pp. 53–6. The Dodder-plant. Pl. 12. T. S. of Dodder (*Cuscuta*) in its host, double stained × 75.
„ „ Studies in Microscopical Science.
Cf. *Micr. News*, IV. (1884) p. 242.
Vol. II. No. 23. Sec. I. No. 12. pp. 45–8. Human Cerebrum. Plate 12. No. 24. Sec. II. No. 12. pp. 47–50. Secondary Tissue. Pl. 12. T. S. Stem of Maple showing annual rings × 50.

Cox, C. F.—Cement for Mounting.
[Correction as to the material he employs for his finishing cement.]
Amer. Mon. Micr. Journ., V. (1884) p. 140 (cf. also p. 132).

Davis, G. E.—The President's Address.
[Deals with "the use of the various processes in connection with microscopical manipulation which have been so universally employed during the past few years" and "the past history of the Microscope."]
Ann. Rep. Manchester Micr. Soc., 1883-4, pp. 60–72.

---

* Nature, xxviii. (1883) pp. 389–93 (2 figs.). See also Proc. Roy. Soc., xxxv (1883) pp. 149–51.

DIPPEL, L.—J. D. Möller's Probeobjecte in Phosphorlösung. (J. D. Möller's test-objects in solution of Phosphorus.) [*Post.*]
Zeitschr. f. Wiss. Mikr., I. (1884) pp. 413–4.

E., H. L.—Mounting Infusoria.
[Reply to H. M. J. Underhill. Chromic Oxydichloride acid = Chlorochromic acid.]
Sci.-Gossip, 1884, p. 185.

EHRENBAUM, E.—Ueber eine Methode zur Anfertigung von Dünnschlitten zoologischer Objecte. (On a method of preparing thin sections of zoological objects.) [*Post.*] *Zeitschr. f. Wiss. Mikr.*, I. (1884) pp. 414–5.

ERRERA, L.—Coupes de tiges colorées par la Canarine. (Sections of stems stained by Canarine.) [*Supra*, p. 815.]
Bull. Soc. Belg. Micr., X. (1884) p. 183.

" " Sur l'emploi de l'encre de Chine en Microscopie. (On the employment of Chinese Ink in Microscopy.) [*Post.*]
Bull. Soc. Belg. Micr., X. (1884) pp. 184–8.

FLEMMING, W.—Mittheilungen zur Färbetechnik. (Notes on Staining.) [*Post.*]
Zeitschr. f. Wiss. Mikr., I (1884) pp. 349–61.

FOL, H.—Nouvelle Méthode pour le Transvasage de Bouillons stérilisés et le dosage des germes vivants contenus dans l'eau.
Arch. Sci. Phys. et Nat., XI. (1884) pp. 557–74 (1 pl.).

" " Remarques supplémentaires sur la technique du perchlorure de Fer. (Supplementary remarks on the technic of perchloride of Iron.) [*Supra*, p. 813.]
Arch. Zool. Expér. et Gén., II. (1884) p. xi.

" " Contribution à la technique des Injections. (Contribution to the technic of Injections.) [*Ante*, p. 312.]
Arch. Zool. Expér. et Gén., II. (1884) p. xii.

FRANCOTTE, P.—Exhibition of Thoma Microtome by Jung, with foot entirely of bronze, and so protected from the effects of sea-water or the moist and salt air of maritime laboratories. *Bull. Soc. Belg. Micr.*, X. (1884) pp. 157–8.

FREEBORN, G. C.—Celloidin for Imbedding. [*Supra*, p. 822.]
Amer. Mon. Micr. Journ., V. (1884) pp. 127–8.

GAGE, S. H.—A Starch Injection Mass. [*Post.*]
Amer. Natural., XVIII. (1884) pp. 958–60, from the *New York Med. Journ.*, June 7th, 1884.

GERLACH, L.—Technische Notiz. (Technical Notes.) [*Post.*]
Untersuch. Anat. Inst. Erlangen, I. (1883).
Cf. *Zeitschr. f. Wiss. Mikr.*, I. (1884) pp. 436–8.

GIERKE, H.—Färberei zu Mikroskopischen Zwecken. (Stains for Microscopical Purposes.) (*Contd.*) *Zeitschr. f. Wiss. Mikr.*, I. (1884) pp. 372–408.

GOTTSCHAU, M.—Vorzüge und Nachtheile Verschiedener Mikrotome und ihrer Hilfsapparate. (Advantages and disadvantages of different Microtomes and their auxiliary apparatus.) [*Post.*]
Zeitschr. f. Wiss. Mikr., I. (1884) pp. 327–48 (12 figs.).

GRAM, C.—Ueber die isolirte Färbung der Schizomyceten in Schnitt- und Trockenpräparaten. (On the isolated staining of Schizomycetes in sections and dry preparations.) [*Supra*, p. 817.] *Fortschr. d. Medicin*, II. (1884) No. 6.
Bot. Centralbl., XVIII. (1884) p. 383.

GRANT, F.—Bacteria and the Microscope.
[Reply to "Amateur," *ante*, p. 630.]
Engl. Mech., XXXIX. (1884) pp. 490–1.

GRAY, E.—Glycerin in Mounting.
[Recommendation not to use an acid glycerin.]
Amer. Mon. Micr. Journ., V. (1884) p. 140.

Griffith's (E. H.) Turntable. [*Supra*, p. 826.]
Amer. Mon. Micr. Journ., V. (1884) p. 126 (1 fig.).

GROVE, W. B.—See p. 810.

HARDY, J. D.—Contrivance for collecting and examining aquatic specimens whilst out on excursions. [*Supra*, p. 803.]
Journ. Quek. Micr. Club, II. (1884) pp. 55–6.

HEURCK, H. VAN.—De l'emploi du Styrax et du liquidambar en remplacement du baume du Canada. (On the employment of Styrax and liquidambar in place of Canada Balsam.) [*Supra*, p. 827.]
Bull. Soc. Belg. Micr., X. (1884) pp. 178-82.

HITCHCOCK, R.—The preparation of Shellac Cement. [*Supra*, p. 828.]
Amer. Mon. Micr. Journ., V. (1884) pp. 131-2.

„ „ Microscopical Technic.
Amer. Mon. Micr. Journ., V. (1884) pp. 132-4, 147-9.

INGPEN, J. E.—Smith's Mounting Medium.
["He did not think he had ever seen a slide of *Amphipleura* so well shown as the one which Mr. Nelson exhibited, which was mounted by Prof. Smith. No doubt the objective and the manner of showing it had something to do with the matter, but there was also no doubt that something was due to the medium. He could only say that probably the exhibition had never been surpassed or equalled, and the fact was to be recorded as an era in the history of resolution."]
Journ. Quek. Micr. Club, II. (1884) p. 43.

KAROP, G.—Section-cutting. *Abstr. Proc. Western Micr. Club*, 1883-4, p. 12.

KESTEVEN, W. B.—On Staining Fluids for Sections of Brain and Spinal Cord.
Sci. Monthly, II. (1884) p. 138.

KLEIN.—[Weigert's] Staining Fluid for Sections of Tubercle-Bacilli.
[*Supra*, p. 818.] *Practitioner*, XXXIII. (1884) p. 35.

LYON, H. N.—A New Mailing Case. [*Supra*, p. 829.]
The Microscope, IV. (1884) p. 179.

MURRAY, F. W.—Celloidin for Imbedding.
[Similar to G. C. Freeborn's directions, *supra*, p. 822.]
Amer. Mon. Micr. Journ., V. (1884) p. 128.

NEALEY, E. T.—A rapid method for making Bone and Teeth Sections. [*Post.*]
Amer. Mon. Micr. Journ., V. (1884) pp. 142-4.

NELSON, E. M.—Bacteria and the Microscope.
[Reply to "Amateur," *ante*, p. 630.]
Engl. Mech., XXXIX. (1884) p. 517.

Peirce's (J.) Slides.
["Intended to prevent the drying of specimens during several hours' continuous observation. A rather deep circular cut is ground in the middle of each slide about 1/2 in. in diameter, which is intended to hold a sufficient quantity of the water to prevent evaporation from under the cover within the cut. It is expected that physicians will find these slides useful."]
Amer. Mon. Micr. Journ., V. (1884) p. 139.

PILLSBURY, J. H.—[Hinman's] Device for Mounting. [*Supra*, p. 827.]
Amer. Mon. Micr. Journ., V. (1884) p. 140.

PURSER, J. M.—A Manual of Histology and of Histological Methods. viii. and 396 pp. 8vo, Dublin, 1884.
[Contains an Introduction (pp. 1-11) on the Microscope and its use, and an Appendix (pp. 339-86) on measuring, drawing, determining magnifying power, injecting, hardening, embedding, cutting, mounting, summary of reagents, &c. In the Introduction it is stated that "the image must always be formed for each eye-piece at a certain distance below the latter."]

RATABOUL, J.—Les Diatomées. Récolte et preparation. (The Diatomaceæ. Collection and preparation.) *Concld.*
Journ. de Microgr., VIII. (1884) pp. 451-4.

SLACK, H. J.—Pleasant Hours with the Microscope.
[Thrips—Fungi—Heaths.]
Knowledge, VI. (1884) pp. 125-6 (5 figs.), 179-80 (1 fig.), 230-1 (4 figs.).

SMITH, W. D.—On Staining Vegetable Tissues.
[Report of Demonstration.]
Journ. Quek. Micr. Club, II. (1884) pp. 46-52.

Sorby, H. C.—On the detection of Sewage Contamination by the use of the Microscope, and on the purifying action of minute Animals and Plants.
[*Post.*] *Journ. Soc. Arts*, XXXII. (1884) pp. 929–30.

Stowell, C. H.—Studies in Histology. IV. Staining.
The Microscope, IV. (1884) pp. 149–53.

" " How to harden Balsam Mounts.
[Reply to inquiry how to harden balsam mounts quickly and safely. "We have never tried to hasten the drying or hardening of the balsam. Should we desire to have a mount become hard quickly we would use balsam of such a consistence that it was fluid only when warm and quite solid and firm when cold, or we could expose the mounted preparation to a low temperature; this could be accomplished by placing the mount in a drying oven or in a sand bath. Nearly all specimens, however, can be mounted in warm balsam without fear of injury, and then as soon as the balsam becomes cold it is firm and hard."]
The Microscope, IV. (1884) p. 159.

" " Studies in Histology. V.
[Metallic stains.—Mounting.]
The Microscope, IV. (1884) pp. 171–6.

" " A new solid Watch-glass. [*Post.*]
The Microscope, IV. (1884) pp. 176–7.

Sudduth, W. X.—Dento-embryonal Histology and Technology. 19 pp. and 12 figs. 8vo, Chicago, 1884.

W., A. W.—Mounting Fresh-water Algæ.
["After trying all sorts of media . . . . . I came to the conclusion that none was so good as plain water with the least addition of camphor water to prevent fungoid growths." Also suggests to preserve the green colour (1) the use of water recently boiled and then closed up in a flask to minimise the amount of air dissolved in it; (2) to put the slide in the dark immediately after mounting.]
Micr. News, IV. (1884) p. 216.

Wagstaff, E. H.—Pond Life in Winter.
[List of objects found in one haul.]
Amer. Mon. Micr. Journ., V. (1884) pp. 144–5.

Whitman, C. O.—A simple Section-smoother.
[Kingsley's, *ante*, p. 659. "For use with the Sterling (well) Microtome it is evidently ill adapted, for the ends which come underneath the blade would interfere with the work."]
Amer. Natural., XVIII. (1884) p. 844 (1 fig.).

Wichmann, A.—Ueber eine Methode zur Isolirung von Mineralien behuf ihrer mikrochemischen Untersuchung. (On a method for isolating minerals for their investigation micro-chemically.) [*Post.*]
Zeitschr. f. Wiss. Mikr., I. (1884) pp. 417–9.

Wilder and Gage.—On the use of Vaseline to prevent the loss of Alcohol from specimen Jars.
[Used *inter alia* to prevent the sticking of the covers or stoppers of cement vials.]
Proc. Amer. Assoc. Adv. Sci., XXXII. p. 318.
Cf. *Amer. Natural.*, XVIII. (1884) p. 845.

Wolle, F.—Fresh-water Algæ.
[Directions for collecting.]
Amer. Mon. Micr. Journ., V. (1884) pp. 129–30, from 'Desmids of the United States.'

The Journal is issued on the second Wednesday of
February, April, June, August, October, and December.

Ser. II.
Vol. IV. Part 6. DECEMBER, 1884. To Non-Fellows, Price 5s.

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

FRANK CRISP, LL.B., B.A.,

One of the Secretaries of the Society
and a Vice-President and Treasurer of the Linnean Society of London;

WITH THE ASSISTANCE OF THE PUBLICATION COMMITTEE AND

A. W. BENNETT, M.A., B.Sc., *Lecturer on Botany at St. Thomas's Hospital,*

F. JEFFREY BELL, M.A., *Professor of Comparative Anatomy in King's College,*

S. O. RIDLEY, M.A., *of the British Museum,* **JOHN MAYALL, JUN.,**
AND **FRANK E. BEDDARD, M.A.,**
FELLOWS OF THE SOCIETY.

WILLIAMS & NORGATE,
LONDON AND EDINBURGH.

PRINTED BY WM. CLOWES AND SONS, LIMITED,] [STAMFORD STREET AND CHARING CROSS.

CONTENTS.

SUMMARY OF CURRENT RESEARCHES, &c.—*continued.*

SUMMARY OF CURRENT RESEARCHES, &c.—*continued.*

MICROSCOPY.

ROYAL MICROSCOPICAL SOCIETY.

COUNCIL.

ELECTED 13th FEBRUARY, 1884.

PRESIDENT.

Rev. W. H. Dallinger, F.R.S.

VICE-PRESIDENTS.

John Anthony, Esq., M.D., F.R.C.P.L.
Prof. P. Martin Duncan, M.B., F.R.S.
James Glaisher, Esq., F.R.S., F.R.A.S.
Charles Stewart, Esq., M.R.C.S., F.L.S.

TREASURER.

Lionel S. Beale, Esq., M.B., F.R.C.P., F.R.S.

SECRETARIES.

Frank Crisp, Esq., LL.B., B.A., V.P. & Treas. L.S.
Prof. F. Jeffrey Bell, M.A., F.Z.S.

Twelve other MEMBERS of COUNCIL.

Alfred William Bennett, Esq., M.A., B.Sc., F.L.S.
Robert Braithwaite, Esq., M.D., M.R.C.S., F.L.S.
G. F. Dowdeswell, Esq., M.A.
J. William Groves, Esq.
John E. Ingpen, Esq.
John Matthews, Esq., M.D.
John Mayall, Esq., Jun.
Albert D. Michael, Esq., F.L.S.
John Millar, Esq., L.R.C.P.Edin., F.L.S.
William Millar Ord, Esq., M.D., F.R.C.P.
Urban Pritchard, Esq., M.D.
William Thomas Suffolk, Esq.

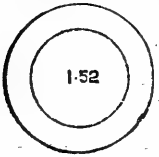
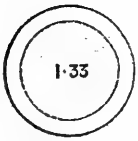
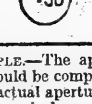
LIBRARIAN and ASSISTANT SECRETARY.

Mr. James West.

I. Numerical Aperture Table.

The "APERTURE" of an optical instrument indicates its greater or less capacity for receiving rays from the object and transmitting them to the image, and the aperture of a Microscope objective is therefore determined by the ratio between its focal length and the diameter of the emergent pencil at the plane of its emergence—that is, the utilized diameter of a single-lens objective or of the back lens of a compound objective.

This ratio is expressed for all media and in all cases by $n \sin u$, n being the refractive index of the medium and u the semi-angle of aperture. The value of $n \sin u$ for any particular case is the "*numerical aperture*" of the objective.

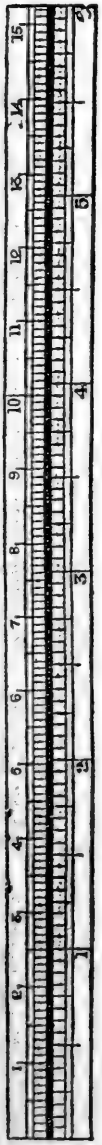
Diameters of the Back Lenses of various Dry and Immersion Objectives of the same Power (⅛ in.) from 0·50 to 1·52 N. A.	Numerical Aperture. ($n \sin u = a$.)	Angle of Aperture ($= 2u$). *Dry* Objectives. ($n = 1$.)	*Water-Immersion* Objectives. ($n = 1{\cdot}33$.)	*Homogeneous-Immersion* Objectives. ($n = 1{\cdot}52$.)	Illuminating Power. (a^2.)	Theoretical Resolving Power, in Lines to an Inch. ($\lambda = 0{\cdot}5269\ \mu$ = line E.)	Penetrating Power. $\left(\frac{1}{a}\right)$
	1·52	..	..	180° 0′	2·310	146,528	·658
	1·50	..	..	161° 23′	2·250	144,600	·667
	1·48	..	..	153° 39′	2·190	142,672	·676
	1·46	..	..	147° 42′	2·132	140,744	·685
	1·44	..	..	142° 40′	2·074	138,816	·694
	1·42	..	..	138° 12′	2·016	136,888	·704
	1·40	..	..	134° 10′	1·960	134,960	·714
	1·38	..	..	130° 26′	1·904	133,032	·725
	1·36	..	..	126° 57′	1·850	131,104	·735
	1·34	..	..	123° 40′	1·796	129,176	·746
	1·33	..	180° 0′	122° 6′	1·770	128,212	·752
	1·32	..	165° 56′	120° 33	1·742	127,248	·758
	1·30	..	155° 38′	117° 34′	1·690	125,320	·769
	1·28	..	148° 28′	114° 44′	1·638	123,392	·781
	1·26	..	142° 39′	111° 59′	1·588	121,464	·794
	1·24	..	137° 36′	109° 20′	1·538	119,536	·806
	1·22	..	133° 4′	106° 45′	1·488	117,608	·820
	1·20	..	128° 55′	104° 15′	1·440	115,680	·833
	1·18	..	125° 3′	101° 50′	1·392	113,752	·847
	1·16	..	121° 26′	99° 29′	1·346	111,824	·862
	1·14	..	118° 00′	97° 11′	1·300	109,896	·877
	1·12	..	114° 44′	94° 56′	1·254	107,968	·893
	1·10	..	111° 36′	92° 43′	1·210	106,040	·909
	1·08	..	108° 36′	90° 33′	1·166	104,112	·926
	1·06	..	105° 42′	88° 26′	1·124	102,184	·943
	1·04	..	102° 53′	86° 21′	1·082	100,256	·962
	1·02	..	100° 10′	84° 18′	1·040	98,328	·980
	1·00	180° 0′	97° 31′	82° 17′	1·000	96,400	1·000
	0·98	157° 2′	94° 56′	80° 17′	·960	94,472	1·020
	0·96	147° 29′	92° 24′	78° 20′	·922	92,544	1·042
	0·94	140° 6′	89° 56′	76° 24′	·884	90,616	1·064
	0·92	133° 51′	87° 32′	74° 30′	·846	88,688	1·087
	0·90	128° 19′	85° 10′	72° 36′	·810	86,760	1·111
	0·88	123° 17′	82° 51′	70° 44′	·774	84,832	1·136
	0·86	118° 38′	80° 34′	68° 54′	·740	82,904	1·163
	0·84	114° 17′	78° 20′	67° 6′	·706	80,976	1·190
	0·82	110° 10′	76° 8′	65° 18′	·672	79,048	1·220
	0·80	106° 16′	73° 58′	63° 31′	·640	77,120	1·250
	0·78	102° 31′	71° 49′	61° 45′	·608	75,192	1·282
	0·76	98° 56′	69° 42′	60° 0′	·578	73,264	1·316
	0·74	95° 28′	67° 36′	58° 16′	·548	71,336	1·351
	0·72	92° 6′	65° 32′	56° 32′	·518	69,408	1·389
	0 70	88° 51′	63° 31′	54° 50′	·490	67,480	1·429
	0·68	85° 41′	61° 30′	53° 9′	·462	65,552	1·471
	0·66	82° 36′	59° 30′	51° 28′	·436	63,624	1·515
	0·64	79° 35′	57° 31′	49° 48′	·410	61,696	1·562
	0·62	76° 38′	55° 34′	48° 9′	·384	59,768	1·613
	0·60	73° 44′	53° 38′	46° 30′	·360	57,840	1·667
	0·58	70° 54′	51° 42′	44° 51′	·336	55,912	1·724
	0·56	68° 6′	49° 48′	43° 14′	·314	53,984	1·786
	0·54	65° 22′	47° 54′	41° 37′	·292	52,056	1·852
	0·52	62° 40′	46° 2′	40° 0′	·270	50,128	1·923
	0·50	60° 0′	44° 10′	38° 24′	·250	48,200	2·000

EXAMPLE.—The apertures of four objectives, two of which are dry, one water-immersion, and one oil-immersion, would be compared on the *angular* aperture view as follows:—106° (air), 157° (air), 142° (water), 130° (oil).
Their actual apertures are, however, as ·80 ·98 1·26 1·33 or their numerical apertures.

II. Conversion of British and Metric Measures.

(1.) Lineal.

Scale showing the relation of Millimetres, &c., to Inches.



1000 μ =1 mm.
10 mm.=1 cm.
10 cm. =1 dm.
10 dm. =1 metre.

Micromillimetres, &c., into Inches, &c.

μ	ins.	mm.	ins.	mm.	ins.
1	·000039	1	·039370	51	2·007892
2	·000079	2	·078741	52	2·047262
3	·000118	3	·118111	53	2·086633
4	·000157	4	·157482	54	2·126003
5	·000197	5	·196852	55	2·165374
6	·000236	6	·236223	56	2·204744
7	·000276	7	·275593	57	2·244115
8	·000315	8	·314963	58	2·283485
9	·000354	9	·354334	59	2·322855
10	·000394	10 (1 cm.)	·393704	60 (6 cm.)	2·362226
11	·000433	11	·433075	61	2·401596
12	·000472	12	·472445	62	2·440967
13	·000512	13	·511816	63	2·480337
14	·000551	14	·551186	64	2·519708
15	·000591	15	·590556	65	2·559078
16	·000630	16	·629927	66	2·598449
17	·000669	17	·669297	67	2·637819
18	·000709	18	·708668	68	2·677189
19	·000748	19	·748038	69	2·716560
20	·000787	20 (2 cm.)	·787409	70 (7 cm.)	2·755930
21	·000827	21	·826779	71	2·795301
22	·000866	22	·866150	72	2·834671
23	·000906	23	·905520	73	2·874042
24	·000945	24	·944890	74	2·913412
25	·000984	25	·984261	75	2·952782
26	·001024	26	1·023631	76	2·992153
27	·001063	27	1·063002	77	3·031523
28	·001102	28	1·102372	78	3·070894
29	·001142	29	1·141743	79	3·110264
30	·001181	30 (3 cm.)	1·181113	80 (8 cm.)	3·149635
31	·001220	31	1·220483	81	3·189005
32	·001260	32	1·259854	82	3·228375
33	·001299	33	1·299224	83	3·267746
34	·001339	34	1·338595	84	3·307116
35	·001378	35	1·377965	85	3·346487
36	·001417	36	1·417336	86	3·385857
37	·001457	37	1·456706	87	3·425228
38	·001496	38	1·496076	88	3·464598
39	·001535	39	1·535447	89	3·503968
40	·001575	40 (4 cm.)	1·574817	90 (9 cm.)	3·543339
41	·001614	41	1·614188	91	3·582709
42	·001654	42	1·653558	92	3·622080
43	·001693	43	1·692929	93	3·661450
44	·001732	44	1·732299	94	3·700820
45	·001772	45	1·771669	95	3·740191
46	·001811	46	1·811040	96	3·779561
47	·001850	47	1·850410	97	3·818932
48	·001890	48	1·889781	98	3·858302
49	·001929	49	1·929151	99	3·897673
50	·001969	50 (5 cm.)	1·968522	100 (10 cm.=1 decim.)	
60	·002362				
70	·002756				
80	·003150				
90	·003543				
100	·003937				
200	·007874				
300	·011811				
400	·015748				
500	·019685				
600	·023622				
700	·027559				
800	·031496				
900	·035433				
1000 (=1 mm.)					

decim.	ins.
1	3·937043
2	7·874086
3	11·811130
4	15·748173
5	19·685216
6	23·622259
7	27·559302
8	31·496346
9	35·433389
10 (1 metre)	39·370432
	= 3·280869 ft.
	= 1·093623 yds.

Inches, &c., into Micromillimetres, &c.

ins.	μ
1/25000	1·015991
1/20000	1·269989
1/15000	1·693318
1/10000	2·539977
1/9000	2·822197
1/8000	3·174972
1/7000	3·628539
1/6000	4·233295
1/5000	5·079954
1/4000	6·349943
1/3000	8·466591
1/2500	12·699886
1/1000	25·399772
	mm.
1/900	·028222
1/800	·031750
1/700	·036285
1/600	·042333
1/500	·050800
1/450	·056444
1/400	·063499
1/350	·072571
1/300	·084666
1/250	·101599
1/200	·126999
1/150	·169332
1/100	·253998
1/50	·507995
1/25	1·015991
1/20	1·269989
1/16	1·587486
1/13	1·693318
1/12	2·116648
1/10	2·539977
1/8	3·174972
1/6	4·233295
2/16	4·762457
1/4	5·079954
1/3	6·349943
5/16	7·937429
2/5	9·524915
	cm.
7/16	1·111240
1/2	1·269989
9/16	1·428737
5/8	1·587486
11/16	1·746234
3/4	1·904983
12/16	2·063732
7/8	2·222480
15/16	2·381229
1	2·539977
2	5·079954
3	7·619932
	decim.
4	1·015991
5	1·269989
6	1·523986
7	1·777984
8	2·031982
9	2·285979
10	2·539977
11	2·793975
1 ft.	3·047973
	metres.
1 yd. =	·914392

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

FRANK CRISP, LL.B., B.A.,

one of the Secretaries of the Society and a Vice-President and Treasurer of the Linnean Society of London;

WITH THE ASSISTANCE OF THE PUBLICATION COMMITTEE AND

A. W. BENNETT, M.A., B.Sc., Lecturer on Botany at St. Thomas's Hospital, | F. JEFFREY BELL, M.A., Professor of Comparative Anatomy in King's College,

S. O. RIDLEY, M.A., of the British Museum, JOHN MAYALL, Jun., and FRANK E. BEDDARD, M.A.,

FELLOWS OF THE SOCIETY.

THIS Journal is published bi-monthly, on the second Wednesday of the months of February, April, June, August, October, and December. It varies in size, according to convenience, but does not contain less than 9 sheets (144 pp.) with Plates and Woodcuts as required. The price to non-Fellows is 5*s.* per Number.

The Journal comprises:

(1.) The TRANSACTIONS and the PROCEEDINGS of the Society: being the Papers read and Reports of the business transacted at the Meetings of the Society, including any observations or discussions on the subjects brought forward.

(2.) SUMMARY of CURRENT RESEARCHES relating to ZOOLOGY and BOTANY (principally Invertebrata and Cryptogamia, with the Embryology and Histology of the higher Animals and Plants), and MICROSCOPY (properly so called): being abstracts of or extracts from the more important of the articles relating to the above subjects contained in the various British and Foreign Journals, Transactions, &c., from time to time added to the Library.

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 12*s.* 6*d.* per half-sheet of 8 pages, or less, including cover, for a minimum number of 100 copies, and 6*s.* per 100 plates, if plain. Prepayment by P.O.O. is requested.

All communications as to the Journal should be addressed to the Editor, Royal Microscopical Society, King's College, Strand, W.C.

Published for the Society by

WILLIAMS AND NORGATE,

LONDON AND EDINBURGH.

ROYAL MICROSCOPICAL SOCIETY.

MEETINGS FOR 1884, at 8 p.m.

Wednesday,	JANUARY 9	Wednesday,	MAY 14
„	FEBRUARY 13	„	JUNE 11
	(*Annual Meeting for Election of Officers and Council.*)	„	OCTOBER 8
„	MARCH 12	„	NOVEMBER 12
„	APRIL 9	„	DECEMBER 10

THE "SOCIETY" STANDARD SCREW.

The Council have made arrangements for a further supply of Gauges and Screw-tools for the "SOCIETY" STANDARD SCREW for OBJECTIVES.

The price of the set (consisting of Gauge and pair of Screw-tools) is 12*s.* 6*d.* (post free 12*s.* 10*d.*). Applications for sets should be made to the Assistant-Secretary.

For an explanation of the intended use of the gauge, see Journal of the Society, I. (1881) pp. 548–9.

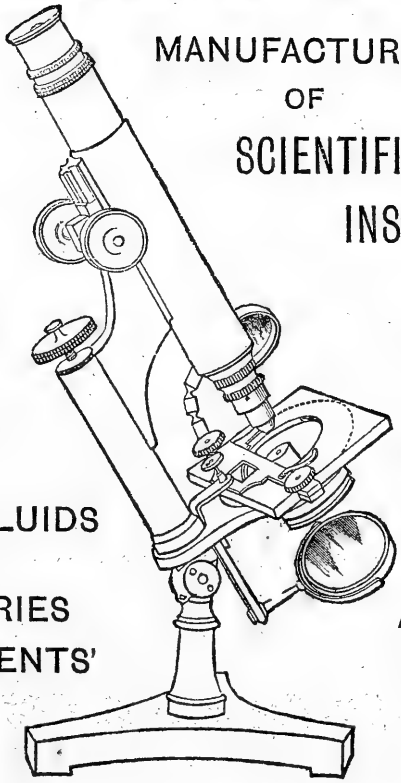
ADVERTISEMENTS FOR THE JOURNAL.

Mr. CHARLES BLENCOWE, of 75, Chancery Lane, W.C., is the authorized Agent and Collector for Advertising Accounts on behalf of the Society.

CHARLES COPPOCK,

LATE
PARTNER WITH
R. & J. BECK.

MANUFACTURER
OF
SCIENTIFIC
INSTRUMENTS.



PATHOLOGICAL
AND
PHYSIOLOGICAL
PREPARATIONS.

STAINING FLUIDS
AND ALL
ACCESSORIES
FOR STUDENTS'
USE.

Microscopes
for
Students and
Amateurs.

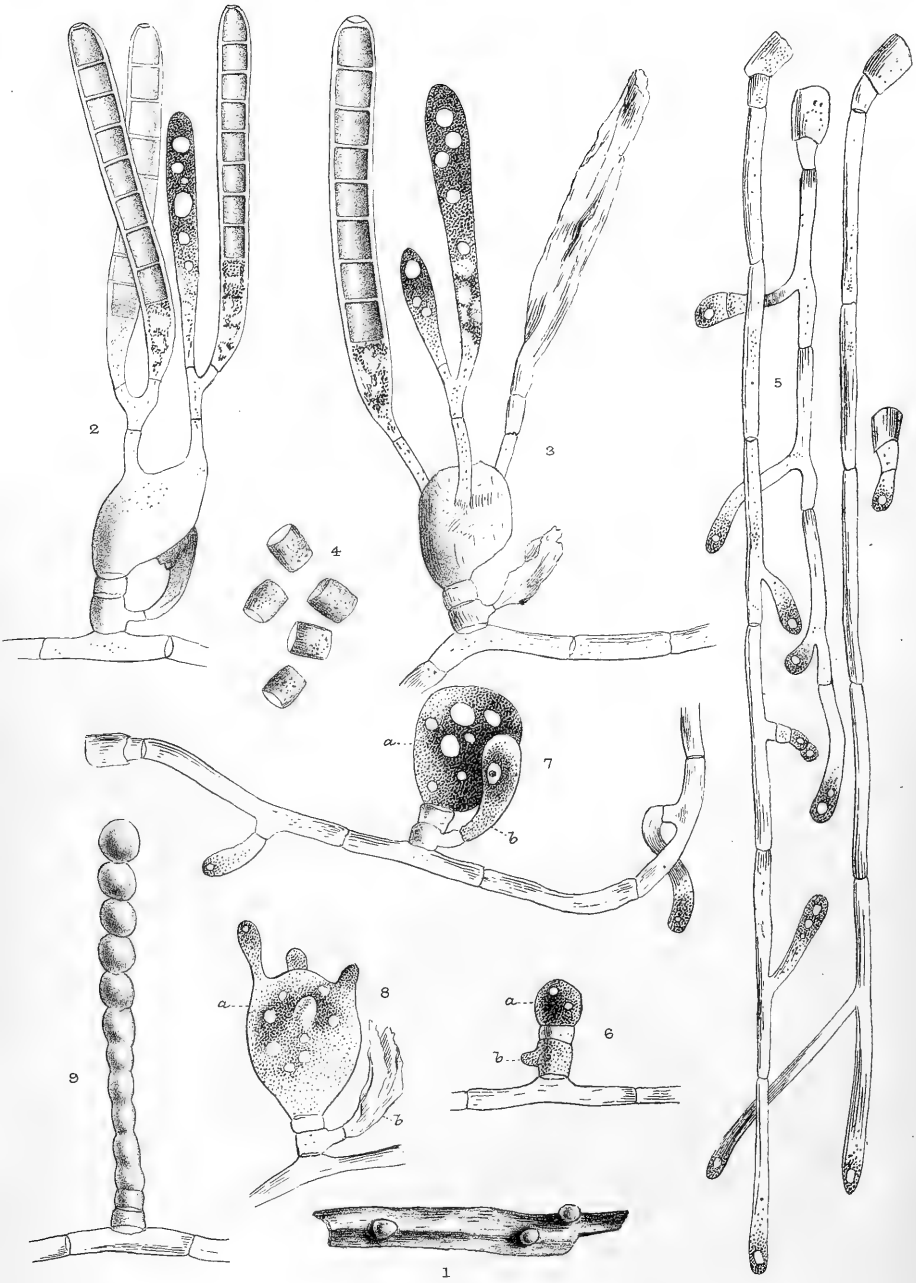
ILLUSTRATED
CATALOGUE,
2s.

100, NEW BOND STREET,
LONDON, W.

N.B. SPECTACLES!!

OCULISTS' PRESCRIPTIONS RECEIVE PERSONAL ATTENTION.

AGENT FOR W. H. BULLOCH, CHICAGO, ILLS., U.S.A.
R. H. SPENCER & CO., N.Y., U.S.A.
JAMES L. PEASE, MASS., U.S.A.
" M. PRAZMOWSKI, PARIS.
M. A. NACHET, PARIS.



G. Massee del.

West, Newman & Co. lith.

Milowia nivea.

JOURNAL

OF THE

ROYAL MICROSCOPICAL SOCIETY.

DECEMBER 1884.

TRANSACTIONS OF THE SOCIETY.

XVIII.—*Description and Life-history of a new Fungus, Milowia nivea.*

By G. Massee, F.R.M.S.

(*Read 12th November*, 1884.)

PLATE XII.

Milowia n. gen.—Pulvinate. Monœcious. Mycelium sparsely septate, branched, flexuous, giving origin to numerous lateral fertile three-celled branches. Pollinodium clavate, springing from the basal cell of the fertile branch. Carpogonium formed from the terminal cell of the fertile branch, broadly obovate, producing from near its apex from two to five cylindrical octosporous asci.

M. nivea n. sp.—Tufts globose, minute, white; sporidia colourless, cylindrical truncate; conidia globose, moniliform, occupying the same position as the carpogonium when the latter is not developed. Forming minute snow-white spots on decaying leaves of *Blysmus compressus*. When seen under a low power the plants look like minute tassels standing erect; the asci are numerous and radiate from a subglobose sterile portion. This plant, one of the simplest of the *Ascomycetes*, approaches in structure the genera *Podosphæra* and *Gymnoascus*, but differs from both in the total

EXPLANATION OF PLATE XII.

Fig. 1.—*Milowia nivea*, nat. size.
Figs. 2, 3.—Portions showing asci in different stages of development, × 750.
Fig. 4.—Sporidia, × 750.
Fig. 5.—Sporidia germinating, × 750.
Figs. 6, 7, 8.—Organs of reproduction in various stages. *a*, carpogonium, *b*, pollinodium, × 750.
Fig. 9.—Branch bearing conidia, × 750.

absence of an envelope to the fructification, and in the carpogonium remaining undivided.

I have much pleasure in naming the genus after my friend Mr. J. T. Milow, to whom I am indebted for many rare and interesting fungi.

The sporidia of this fungus were sown on a glass slip, moistened with a mixture of glycerin and the liquid from decaying rushes, placed under a bell-jar, and kept in the dark. After a few days some of the sporidia showed a slight projection at one end, the exospore split at this point, and the endospore protruded as a hypha. Out of some hundreds of sporidia that germinated only four were observed to give origin to more than one thread, these produced two, one springing from each end. Immediately preceding germination the protoplasm becomes granular and opaque, and contains several large refractive globules of an oily-looking substance; after germination the whole of the contents pass into the mycelium, which is cut off from the cavity of the sporidium by a transverse septum formed close to the latter. The hyphæ after elongating for some distance as simple threads with but few septa, branch repeatedly in a monopodial manner, these in turn give off numerous lateral branches in acropetal succession; some resemble the branch from which they spring, in having cells about four times as long as broad, and are probably organs of nutrition, penetrating the tissues of the host, and undergoing no further modification of form; others, which eventually give origin to the organs of reproduction, may be recognized during the earliest stages of development, by the much shorter cells, not longer than broad, and invariably three in number; of these the terminal one becomes the carpogonium, the basal one gives origin to the pollinodium as a lateral branch, while the central one remains unchanged, and forms the basal cell of the fruit. In some instances the pollinodium is not developed; then the terminal cell of the fertile branch, instead of forming a carpogonium, elongates and gives origin to a chain of conidia; this asexual form of reproduction occurs mixed with the sexual form.

The three cells forming the fertile branch are at first of equal size, but the terminal one, owing to continued growth, soon becomes very much larger than the remaining two, assumes a broadly obovate form, and contains coarsely granular opaque protoplasm, crowded with vacuoles of varying size; this cell is the carpogonium, now ready for fertilization. During the development of the carpogonium, the pollinodium originates as a lateral outgrowth from the basal cell of the reproductive branch; this outgrowth, during elongation, assumes a clavate form, at the same time curving upwards towards the carpogonium; a well-defined nucleus con-

taining one or more nucleoli is present in the semi-transparent fine grained protoplasm, which is cut off from the basal cell by a septum; when fully developed the nucleus disappears, and the pollinodium contains numerous minute granules, floating in a transparent fluid and undergoing active molecular movements; eventually the cell-wall at the apex of the pollinodium is absorbed, when the contents escape and adhere to the surface of the carpogonium. Contact with the substance contained in the pollinodium stimulates the carpogonium to further growth; the vacuoles disappear from its protoplasm, from two to five papillæ appear on its surface near the apex, which grow for some time as slender tubes, then widen and develop into cylindrical asci, into which the protoplasm from the carpogonium passes and becomes resolved into eight sporidia by free cell formation. Not unfrequently the slender tubes branch and give origin to two asci.

The value of the plant above described does not consist so much in the fact of its being a new species added to the already voluminous list of fungi, as to the suggestions it offers relating to the functions of analogous organs met with in the higher fungi, where owing to the difficulty with which the spores germinate under artificial conditions, and complications of structure, the life-history cannot be satisfactorily traced. The carpogonium differs from that of other Ascomycetes in remaining unicellular, and in giving origin to slender spicules which are terminated by the asci, calling to mind the basidium with its sterigmata in the Basidiomycetes. The points of agreement between the pollinodium and certain structures met with in the hymenium of Hymenomycetal fungi, known as *cystidia*, are yet more evident; both are terminal cells of large size, which during development contain a well-marked nucleus; the contents, at first homogeneous, become resolved into minute granules floating in a mucilaginous fluid, which finally escapes through an opening at the apex, and comes in contact with the spore-producing organ. The difficulties attending the practical demonstration of the functions of cystidia will not probably be overcome, but their close morphological agreement with organs, respecting the functions of which no doubt can be entertained, offers strong presumptive evidence of the same physiological function being common to both; this view respecting the nature of cystidia has already been entertained by Hoffmann,* who called them *pollinaria*, without, however, giving any evidence in support of his conclusion; the same may be said of Corda, who termed them *pollinaires*.

* "Die Pollinarien und Spermatien von *Agaricus*." Bot. Ztg., Feb. and March 1856.

The plant under consideration also demonstrates some points necessary for the completion of a theory of sexuality, which may be stated as follows.

Protoplasm contains two substances, the combined action of which enables the plant to perform its vegetative functions, and continue its existence as an individual; the proof of this is the fact that when the two components are differentiated into sexual organs, neither of these alone can perform vegetative functions, which can only be resumed after fertilization has effected a reunion of the requisites. That a separation of vegetative protoplasm has taken place is shown by reagents; glycogen is absent from the basidia (before fertilization) and cystidia of fungi, but is present in the hyphæ and spores; nuclein on the other hand is present in the pollinodium of *Milowia nivea* and in the cystidia of all fungi examined, but absent from every other part of the plant. In *Fucus vesiculosus* and *F. serratus* the oospore behaves similarly to the protoplasm of young parts of the thallus with reagents, but the oosphere and antheridia differ from both and from each other. In other experiments on plants belonging to widely separated families the difference between the sexual and vegetative organs is equally well marked, which, even when the significance from a chemical point of view is not understood, clearly shows a difference of composition, the point of most importance to the present inquiry. Tetragonidia, conidia, and the parthenogenetic reproductive bodies of the *Phæosporeæ* so far as examined give the same reactions as the vegetative parts of the plants to which they belong. This method when more fully developed and verified by extended experiments, may prove of value in determining the sexual or asexual nature of certain reproductive bodies belonging to the lower plants respecting which, at present, opinions are divided. As an example, no difference has been found in the protoplasm of conjugating plants of *Spirogyra*; and the mingling of vegetative protoplasm to form a zygospore, in place of being considered a sexual act, may be looked upon as the precursor of cross fertilization. The advantage of this method over reproduction by conidia consists in the zygospore being an admixture of two individuals, which presumably confers the same benefit as that effected by cross fertilization in the higher plants; the disadvantage, compared with the sexual method, which it shares with reproduction by fission, consisting in the destruction of the parent plant, which survives when parts only are specialized as reproductive organs.

It has been already stated that in *Milowia*, when the pollinodium is not developed, the terminal cell, instead of developing into a carpogonium, produces conidia; had this cell in such instances developed into an organ resembling the carpogonium with its asci,

it would according to present ideas have been considered as an example of parthenogenesis, which can in all cases be explained by assuming the non-differentiation of the vegetative protoplasm, as was proved in this instance, an idea supported by the fact, that in the most satisfactory examples* the male organ is absent or functionally imperfect; this being so, parthenogenesis means a retrogression to the vegetative stage of reproduction, which is not invalidated by the organ retaining the sexual female form.

* Sachs, 'Text-book of Botany,' 2nd English edition, pp. 902–3.

XIX.—*Notes on the Structural Characters of the Spines of Echinoidea. (Cidaridæ.)*

By Professor F. Jeffrey Bell, M.A., Sec. R.M.S.

(*Read 12th November*, 1884.)

Plate XIII.

Notwithstanding the labours of Dr. Carpenter, Mr. Stewart, and Prof. Mackintosh, there still remain points in the structure of the spines of Echinoidea that require much further investigation.

The first problem to which my attention was directed in a research into the characters of the spines of Cidarids may be stated thus. How do these spines grow, and what is the effect of the enveloping crust, or, as it may conveniently be called, the *ostracum*, of the spine? This is, of course, but a branch of the interesting question to which Dr. Carpenter some years ago directed the attention of this Society * when he stated his conviction that the growth of the spine was due to the presence of an "organic basis-substance," and gave up the idea of the possession by the spine of that investing membrane to which, in earlier works, he had ascribed the formative capacity of these organs. This view of the constitution of the Echinid spine is that taken also by Giesbrecht,† whose careful investigation into the minute structure of the teeth of Echinids gives especial value and weight to his opinion; he says, "Das Material, aus welchem der Seeigelzahn, wie auch das ganze Skelett der Echinodermen aufgebaut ist, ist Calciumcarbonat oder vielmehr eine eigenthümliche Mischung desselben mit organischer Substanz."

If this organic substance penetrates the inner parts of the spine, we may regard the cavities, spaces, and canals which are revealed

---

EXPLANATION OF PLATE XIII.

Fig. 1.—Primary spine of *Goniocidaris florigera* (natural size), to show the form of the spine, and the prickle-like processes on its surface.

Fig. 2.—Transverse sections of the same, showing that the prickles are formed not by the crust only, but also by the cancellated tissue.

Fig. 3.—Transverse section of *Phyllacanthus imperialis*, especially to show the mode of arrangement of the cancellated tissue.

Fig. 4.—Transverse section of *Stephanocidaris bispinosa*, in which, as in figs. 2 and 3, the continuation of the canals into the ostracum is distinctly seen.

Fig. 5.—Transverse section of *Salenia profundi*, showing its "acanthostracous" characters.

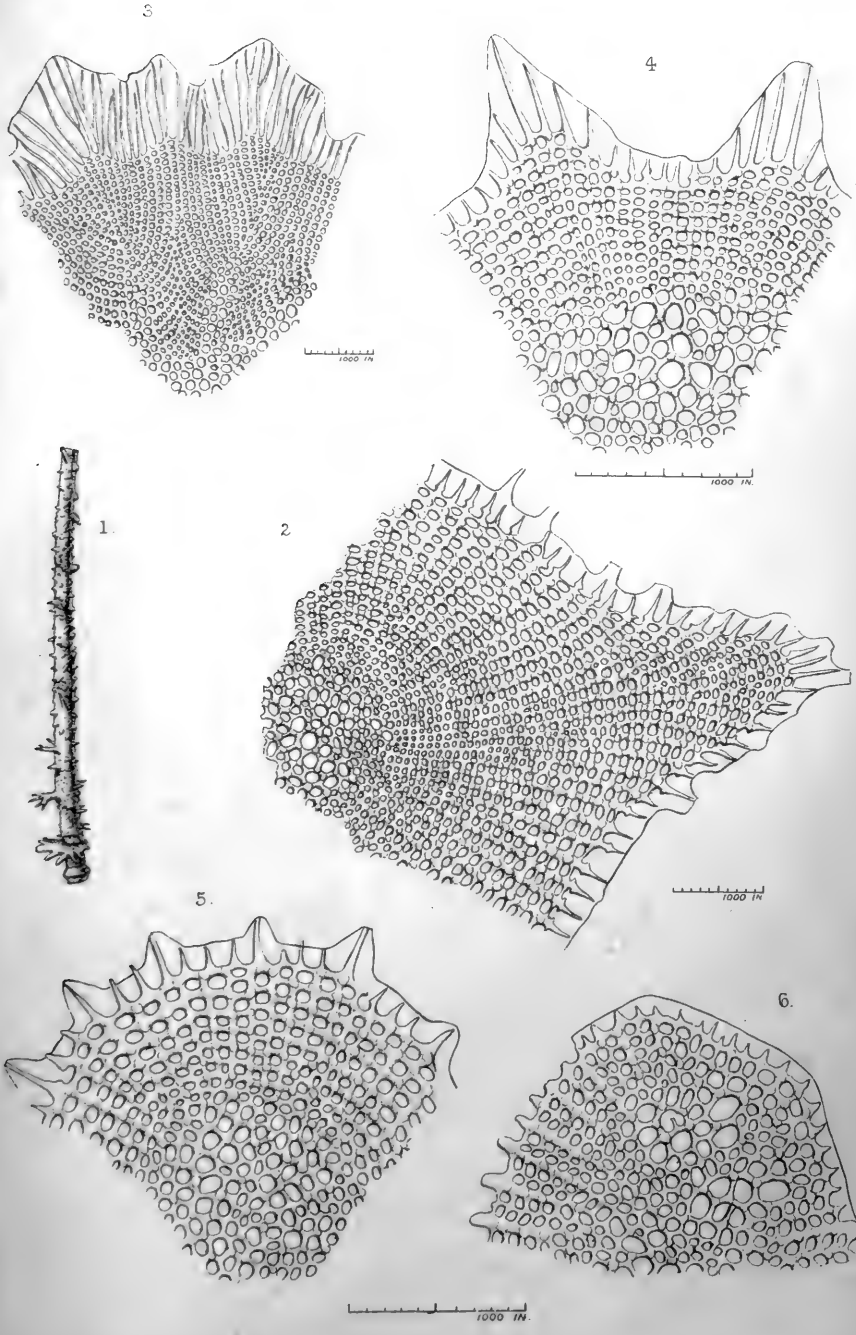
Fig. 6.—Section of tip of spine of *Echinocidaris spatuligera*, to show the mode of distribution of the cap of ostracum.

The scale to which the figures are drawn is shown on the plate.

---

* Monthly Microscopical Journal, iii. (1870) p. 225.

† Morphol. Jahrbuch, vi. (1880) p. 79.



Berjeau & Highley del et lith. Mintern Bros. imp.

Transverse Sections of Spines of Cidarida; Salenia & Echinocidaris.

in transverse sections of dried spines as expressions of its distribution during life.*

With these considerations in our minds let us apply ourselves to the spines of Cidarids. They are by no means so constantly regular and cylindrical in this, as in other groups of Echinoids, and are to be at once distinguished histologically by the presence of the ostracum (the Cidaridæ are the *Acanthostraca* of Mackintosh), which is rarely found on the spines of other or non-Cidarid forms.† Thanks, it is said, to the possession of this outer crust, the spines become swollen out into irregular enlargements, or provided with more or less elegant and prominent ridges, or with a broadened free end. The remarkable differences in the forms of the spines have been ascribed to various causes by various writers. By A. Agassiz ('Revision of the Echini,' p. 653) they are said to be due to "the independent growth of the outer sheath; while in other regular Echini the growth of the outer layer takes place uniformly with the increase in size of the spine." This view, I take it, is a modification of that held by Mr. Stewart (Q. J. M. S., xi. p. 52), who is of opinion that the perisome which invests the spine dies down when the outer crust of the spine has been deposited, consequent on the acceptation of Dr. Carpenter's view as to the existence of a permeating protoplasmic substance. As expressed, however, it fails to convey the ideas of the author definitely to the mind, and, if put into other words, such as—the outer portion of a Cidarid spine grows independently of the inner—it gives an idea of the minute structure of these spines, which can hardly be said to agree with the facts.

If evidence be wanting of the close relation of the inner and outer regions of a spine, reference need only be made to the exact figures given by Stewart or Mackintosh; the former (op. cit.) has published a sketch of a transverse section of *Cidaris annulata* (*C. tribuloides*) in which the dense crust is seen to be traversed by delicate tubules continuous with the spaces that lie between the radiating plates that form the greater part of the spine; and the latter ‡ has given us a figure of *Goniocidaris geranoides* which shows, as sections of its spines always do, that some of the radiating spaces between the plates § extend to quite the extreme edge of the periphery of the spine.

* A student at a marine biological laboratory might well repeat and extend Dr. Carpenter's observations (op. cit.). He would, doubtless, derive considerable aid from the copal method of Koch (cf. Zool. Anzeig., i. (1878) p. 36).

† *Salenia* has a true crust (see fig. 5), and *Echinocidaris* has a crust on the tip of some of its spines.

‡ Trans. R. Irish Acad., xxvi. (1878) pl. ix. fig. 9.

§ It is greatly to be regretted that Prof. Mackintosh has followed Prof. Agassiz in applying a term of such definite significance in histology as "cell" to what are "really interspaces or foramina." Neither convenience nor the advan-

It seems then to be quite certain that there is not the distinction between the outer and inner portion of Cidarid spines which Prof. Agassiz appears to have drawn.

Another view taken with regard to the ostracum is that its presence has the effect of terminating the growth of the spine; the evidence that I have to adduce will, I think, lead us to see that this supposition is not well-founded. I do not know whether Dr. Carpenter would express himself now exactly as he did in 1847, but there is no doubt that what he said then has had a very considerable influence in determining the ideas and statements of succeeding writers. In his well-known Report to the British Association on the microscopic structure of shells he says (p. 125), "This much, however, seems certain, that whatever additions these spines may receive in length they cannot be augmented in diameter, this being fixed in the first instance by the production of the solid calcareous cylinder which forms the exterior of the spine."

The observations which I now proceed to describe seem hardly to support the views so clearly expressed by Dr. Carpenter, and suggest rather the idea that the ostracum grows with the rest of the spine, and retains the protoplasmic ground-substance which is found in the rest of the tissue.

1. As it is clearly impossible to make a transverse section of a spine, and afterwards allow it to continue to grow, one has had to be content with comparing a spine of fair size with one that was a good deal larger, and was taken from a *larger specimen*; this last point is one of some importance, as the different spines of one interambulacral area may vary considerably in length in one and the same individual. The larger spine that I took was one to the size and form of which the smaller might have been fairly expected to grow had not its possessor fallen a victim to a collector.

The tips of two such spines of *Cidaris metularia* measured, in transverse section, 1 mm. and 2·6 mm., while the crust, at its thickest, was ·227 mm. in the smaller, and ·4 mm. in the larger specimen. The basal parts of two spines of the same species were 1·3 and 3 mm. in thickness; the crusts respectively ·17 and ·3 mm. Three spines of *Phyllacanthus imperialis*, in which the transverse section was taken at the middle of their length, measured respectively 3, 4, and 4·75 mm., and had a crust of ·3, ·35, and ·5 mm. thick.

It is clear that, on the theory of determinate growth, as Mr. Stewart has called it, the increase in the size of the spine ought to

---

tage of similarity of nomenclature can be pleaded in defence of a course which is, really, extremely inconvenient, and, so far as nomenclature is concerned, disturbing, if not revolutionary.

be due to the increase in the thickness of the crust, but our observations show that for *Cidaris metularia* (α) while one-fourth of the diameter of the base is crust in the smaller, only one-fifth is crust in the larger specimen, and (β) that of the tip two-fifths is crust in the smaller, but only one-third in the larger specimen. The growth, therefore, is due more to the internal portion than to the external crust, and, as we obtain the same kind of result with the base as with the tip of the spine, we cannot say that the crust is as thin as it is because it has been worn away, or, at any rate, make that more than a very subsidiary reason for the difference. The varying proportions presented by *Phyllacanthus* offer some difficulties on other scores, but it is abundantly clear that the crust does not become proportionately thicker than the interior.

2. The evidence now collected as to the power of growth of the spine as a whole, is supported by the structural characters of the tips of certain spines which are remarkable for their form. One of these, which is perhaps the most striking, is that of *Goniocidaris florigera*, which are widened out at their free ends and provided along their sides with spinose projections in the way that is shown in pl. XIII. fig. 1. A transverse section of such a spine (fig. 2) shows that the outgrowths have a comparatively thin crust, and that the greater part is formed by exactly the same kind of reticular tissue as that which occupies the greater part of the interior of the spine. Here, at any rate, there is a relation between the characters of the surface of the spine, and the disposition of the tissue covered by the ostracum.

Goniocidaris geranoides, a figure of which has been given by Prof. Mackintosh,* is an example of a spine in which the projections are again distinctly formed by the reticular tissue, and not by a crust that is in any sense amorphous. *Phyllacanthus imperialis* (fig. 3) and to a less extent *P. verticillatus*, afford us examples of spines in which the external contour of the crust is distinctly seen to be dependent on the arrangement of the layer within.

3. Finally, to conclude this line of argument, we observe that in all cases the ostracum is penetrated by spaces which we cannot, from what we now know, look upon as being otherwise than occupied during life by a protoplasmic ground-substance. The continuation of the interspaces into the crust is, of course, better seen in some than in other species; fig. 4 shows the arrangement which obtains in *Stephanocidaris bispinosa*, the structure of the spine of which is now illustrated for the first time.

When we combine the information afforded by the facts and figures now offered, with that which has been acquired by pre-

* Loc. cit.

ceding observers, we are, I think, led to the conclusion that, even in the systematic arrangement of the families of Echinoids, some hints of value are to be obtained from a consideration of the facts of spine-structure; there is, in fact, a kind of continuity in histological structure which is not always apparent in the grosser details.

The Cidaridæ, with the simplest, that is fenestrated,* type of spine structure, have in some cases, though not in all (e. g. *Goniocidaris geranoides*, where it is only scattered) a surrounding ring of thicker crust which, as Mackintosh suggests, prevents the softer internal part from being too rapidly worn away; such a crust is found in the Salenidæ, and at the tip of the spines which in *Echinocidaris* are found in the neighbourhood of the mouth.

The fact that it is found in the Salenidæ is really in favour of the value of spine structure as an aid to the phylogenetic systematist, for *Salenia* does by certain, just as much as it does not by other, characters proclaim its relations to *Cidaris*. Similarly *Echinocidaris* stands nearer to the Cidaridæ than does *Echinus*, and, in that portion of the spine which is most liable to be worn down by friction, the interior layer, which is acanthosphenote rather than as in *Cidaris* fenestrate, tissue, is protected by a crust. (fig. 6.)

The figures of *Salenia profundi* (now for the first time given, fig. 5) will show how, even in *Salenia*, there is a tendency to a regular spoke-like arrangement of the inner layers, and a marked reduction in the fenestrate arrangement. Within the limits of the true Cidaridæ stages in the extent of the fenestration, and the regularity of the spoke-like intermediate layers are to be observed: when combined with the inquiry into the relations of other structural characters, to which I hope soon to be able to devote myself, they will perhaps be found to be of use in determining the minor questions of the limitations and relations of the genera of which that family is composed.

That the term Acanthostraca is not synonymous with the name, or the group denoted by it conterminous with that of the Cidaridæ, is, after all, only another way of saying that it takes note of only one structural character, and it does not really afford any ground for neglecting a study which is full of interest and instruction.

The figures of spines, now given for the first time, will be found to explain themselves to those who are acquainted with what has been already done, especially by Prof. Mackintosh.

* I quite agree with Prof. Mackintosh, who says, "Nor can I agree with Prof. Agassiz that the Cidaridæ present us with the most complicated type of spine structure."

XX.—*Researches on the Structure of the Cell-walls of Diatoms—Eupodiscus.** By Dr. J. H. L. Flögel.

(*Read 12th December*, 1883.)

Amongst the specimens of *Triceratium* received from Herr Möller, *Eupodiscus argus* Ehrenb. is well represented, the structure and sculpturing of which I have endeavoured to determine by sections. Researches were formerly made by Slack (25), who considered the membrane to consist of minute spherules. The different appearances this form presents in reflected light as compared with other diatoms, and which point to quite different sculpture details, have been discussed by J. Deby (2, p. 13). Indeed, the sections confirm this, presenting such a peculiar image that it is difficult to institute a comparison with others. The spine of an *Eupodiscus* valve has been described and figured by O. Müller (15, p. 633, pl. xv., fig. 8). Wells asserts that he has seen irregular depressions on the valve, which are closed by a membrane at the base and divided by lines which are coarse at the edge (29).

I send the photograph of a coarse section, being No. 9 of a series of nineteen sections through a valve, which at the same time contains one of the three spines (photograph 8). Only very indistinctly we see in some places that the mass must consist of nearly symmetrical chambers resembling closely in their general outlines the *Triceratium* chambers. If we compare with this the thinnest sections—I have given a drawing of a portion from such a section in fig. 144—it becomes very difficult to trace the chamber-

Fig. 144.

like spaces. Sometimes I see a delicate line like the vertical wall of a *Triceratium*, but in most instances this line is so darkened by what seems a small granular mass of high refracting power that one loses trace of it. I consider this granular mass to consist of numerous excrescences from the chamber-walls, without however being able to give proof for my assertion. Here then is a new field

* In consequence of omissions in the text this could not be printed in its proper place *ante*, p. 672.

for investigation; above all, it will be necessary to cut specimens that are in process of fission in order to ascertain the appearance presented by the chambers in early development, when probably the confused image of the fully developed state will become comprehensible. The condition of the spine is seen in the photograph; it has a distinct cavity with an air-bubble; but no opening exists as far as I can determine. The continuation looks something like the spines, stiff hairs, &c., of insects, which, as is well known, have no opening at the end.

XXI.—*On some Photographs of Broken Diatom Valves, taken by Lamplight.* By Jacob D. Cox, LL.D., F.R.M.S.

(*Read 12th November*, 1884.)

In a series of articles recently published * I gave the typical examples of numerous observations which I considered to warrant the following conclusions:—

(1) The diatom shell is usually formed of two laminæ, one or both of which may be areolated, and may be strengthened by ribs which have been described both as costæ and as canaliculi. (2) The normal form of the areolæ is a circle, and these when crowded together take an hexagonal and sub-hexagonal form. (3) The areolæ are properly pits or depressions in the inner surface of one of the laminæ, so that when two laminæ are applied together, the exterior surfaces of the shell thus formed are approximately smooth, and the cavities are within. (4) The apparent thickening on the exterior of the lines bounding the areolæ in some species, as *Eupodiscus argus*, &c., is not in contravention of, but is in addition to the formation above described. (5) However fine the dotted marking of diatom valves may be, the evidence from the colour of the spaces between the dots, and of the dots themselves, supports the conclusion that they follow the analogy of the coarser forms in which both fracture and colour are found to prove that the dots are areolæ, and the weaker places in the shell.

I have now sent to the Society, through the courtesy of Mr. Mayall, a parcel of photographs of broken diatom shells made by lamplight. They are intended as a contribution to the evidence as to the structure of the diatom valve, and were prepared under the strong belief that the study of broken specimens has not been followed up with the systematic care which their instructiveness would justify.

In my investigations, extending over a considerable number of years, it has been my habit to mark by the Maltwood finder and enter in my note-books the more suggestive examples of broken valves which I found, and especially such as seemed to throw useful light upon the question of structure. How to make this evidence available was a somewhat troublesome problem; but it is one which recent improvements in dry gelatine plates for photography seem to have solved very happily. Other duties prevented my using the daylight hours for work of this kind, and I was for some time deterred from attempting to photograph by lamplight by the fear

* Amer. Mon. Micr. Journ., v. (1881) pp. 45-9, 66-9, 85-9, 104-9; see this Journal *infra*, p. 943.

that it would not be found available for the high powers I desired to use. Amplifications of from one to two thousand diameters were what I wanted to have at command, and until quite lately it did not seem likely that this could be secured in photography by lamplight.

During the preparation of the articles on diatom structure above referred to, I determined, with some hesitation, to test the usefulness of this method of illustration. Beginning in April, I have made between fifty and sixty negatives of what I have called a "broken shell series," and from which the accompanying set is selected.

The apparatus I use is very simple. It consists of Walmsley's photo-micrographic camera with cone of *papier maché* attached, and a common coal-oil lamp with broad flat wick an inch and a half wide. In selecting a lamp I chose one having a strong draught and good combustion giving an intense white flame. In using it the edge of the flame is turned to the Microscope, as in the resolution of difficult tests. To obtain the desired amplification, even with a 1/15 in. objective, the full extension of the camera bellows is necessary, or the use of an amplifier in the body tube. Without pretending to be sure that my method is the best, I will still say that I have thus far got the best results by using the No. 1 eye-piece in the Microscope, and no other amplifier. It seems to me that after correcting the objective with care so as to present the best results to the eye directly, the satisfactoriness of image which is thus produced is best kept by using both objective and eye-piece in photographing, precisely as in ordinary observation, and with the same length of tube; changing nothing but the fine adjustment to correct the focus for the position of the camera screen. Such, at least, is the conclusion I have tentatively reached.

The thing I have specially aimed at has been to correct the objective by the collar with the utmost care to procure sharp definition of the broken edges of the valves, and to reduce the diffraction as much as possible, also, by this means and by the manipulation of the light. After patient experimenting to secure this, I place the tube in a horizontal position and attach it to the camera with as little change of conditions as may be. I use an achromatic condenser which is a slight modification of a Kellner eye-piece, with violet blue modifier and a variety of movable diaphragms and stops at the back. These were not specially provided for photography, but being such as I am in the habit of using in actual investigations, I have, on the principle before stated, continued their use with the camera.

With the exception of one or two negatives, my photographs

have been made with light strictly central; for I have sought to secure dioptric images and to avoid diffraction ones as far as possible. From the list of the photographs it will be seen that the objects have been mounted, some of them dry, some in balsam, and some in the very dense medium of Prof. H. L. Smith. Whilst both the denser medium and the dry mounts have their advantages for purposes such as the resolution of lined surfaces by oblique light, it should be remembered that by the exaggerated contrast in the refractive power of the object and the medium, the prismatic effect of a broken edge is increased. This exaggerated refraction and accompanying diffraction interferes more or less with the true presentation of such a marginal broken line. At first sight it seems much stronger and bolder, and what is coarsely presented is much more easily photographed; but my experience leads me to the opinion that the most truthful presentation of the details is given when the difference in the refractive indices of object and medium is as small as is consistent with the discrimination of the object. The image will, of course, be much fainter, but I find it also more delicately exact and of a better quality. Up to the limit of good definition in balsam, therefore, I prefer to use mounts in this medium, and the result seems to be worth the extra care and nicety required in all parts of the manipulation.

It will be seen from the description of the plates that the exposure of the sensitive film was not always in proportion to the amplification. The greater the difference in refractive index, the more quickly is a negative taken, for reasons already hinted at. The dry mounts and those in Prof. Smith's medium were therefore photographed more quickly than the balsam mounts. Within moderate limits, however, the amplification was varied whilst the time of exposure and the medium remained the same. The plates so taken were not of the same density, but the only important resulting difference was that the denser plates printed more slowly. Again, it is difficult, if not impossible, to manipulate the light so as to make it entirely uniform on different evenings. The lamp may be trimmed a little differently, the state of the atmosphere may affect it, or the plates themselves may not be exactly alike. There will therefore be, at last, room for the exercise of judgment based upon experience in determining the exposure to be given, and one must expect to spoil a plate occasionally.

I will only add that it has been a fixed rule with me to leave the photograph untouched. Any "stopping out," stippling, or retouching in any of the forms known to practical photographers, must, in my opinion, greatly diminish the value of a photograph for scientific purposes by introducing more or less of personal interpretation.

So much as to methods. The facts in structure of which the photographs are evidence, are these:—

1. The character of the costæ in *Navicula major* (*Pinnularia* W. Sm.).

2. The existence of films of silex above and below the large hexagonal cells in *Triceratium favus*, *Coscinodiscus oculus-iridis*, and *Heliopelta*.

3. That the "dots" of the diatoms are areolæ as shown by the fractured edges of a considerable series of examples, ranging from the coarsest to *Pleurosigma angulatum* inclusive.

I do not mean to repeat here the discussion of the subject, but only to present the photographs as illustrative of what I have said in the series of articles which has been mentioned.

The list of the prints which make up this shorter series of "broken shells" is as follows, viz.

No. 5. *Nitzschia scalaris*, and *Navicula sculpta* Ehr. × 650, exposure 6½ minutes. Fracture through rows of dots between the costæ in the *Nitzschia*, and through the irregular rows nearly parallel to the margin in the *Navicula*. From Möller's balsam mount of Södertelge mud (Sweden).

No. 6. *Epithemia turgida* Kütz. × 760, exposure 6½ minutes. Showing sub-rectangular reticulation at broken edge. From same slide as the last.

No. 7. *Navicula lyra* Ehr. × 700, exposure 6½ minutes. Showing fracture through radial row of dots between costæ, and through the dots on the broken edge. From Möller's balsam mount of Samoa sea-mud.

No. 10. *Navicula maculata* Edwards. × 1120, exposure 6½ minutes. Similar fracture to the last. From H. L. Smith's mount of Mobile Bay diatoms in dense medium; ref. index 2·4.

No. 11. *Odontodiscus subtilis* Ehr. × 1375, exposure 10 minutes. Showing wedge-shaped segment broken out, the fracture being through the rows of dots. From Möller's balsam mount of Wedel sea-mud.

No. 14. *Coscinodiscus obscurus* A. Schmidt, × 950, exposure 6½ minutes. Showing close hexagonal and loose circular areolation in same shell. From Möller's balsam mount of Nottingham earth.

No. 17. Same as No. 5. × 960, exposure 6½ minutes.

No. 20. *Odontodiscus subtilis* Ehr. × 1320, exposure 6½ minutes. Showing a radial crack through a row of dots. From same slide as No. 11.

No. 21. *Coscinodiscus oculus-iridis* Ehr. × 1600, exposure 9 minutes. Showing dotted film covering the large hexagonal areolæ and projecting beyond the walls of these. From Möller's balsam mount of Nottingham earth.

No. 22. Same as last, but taken with light a little oblique.

Exposure 12 minutes and plate afterwards intensified with merc. bi-chlor.

No. 23. Another specimen of same, showing group of large central cells with dotted film. × 1600, exposure 14 minutes.

No. 24. *Navicula granulata* Brebisson. × 950, exposure 9 minutes. Showing several fractures through the dots. From H. L. Smith's *species typica* in balsam.

No. 25. *Odontodiscus subtilis* Ehr. × 1100, exposure 14 minutes. Showing crack nearly parallel to the rim and running through the dots. From the same slide as No. 11.

No. 26. *Triceratium favus* Ehr. × 1333, exposure 10 minutes. A fragment showing film with radiating dots over the large hexagons. Dense medium (2·4). Same slide as No. 10.

No. 27. *Actinoptychus Heliopelta* Grunow. × 940, exposure 7 minutes. Showing finely dotted film extending far beyond the large hexagons, and the fracture through the fine dots. From Peticolas' balsam mount of Calvert Co. earth (Maryland).

No. 28. *Coscinodiscus oculus-iridis* Ehr. × 900, exposure 7 minutes. A fragment of the inner film, showing the "eye-spots." From same slide as the last.

No. 29. Same as 28 with slightly different focus.

No. 31. *Pinnularia major* W. Sm. × 870, exposure 6½ minutes. Showing costæ standing out like the teeth of a comb, the thin connecting film being mostly removed. From H. L. Smith's slide of *Nav. rhomboides* in dense medium (2·4).

No. 35. *Navicula granulata* Breb. × 1000, exposure 5½ minutes. Showing fractured margin, the break being through the dots. From H. L. Smith's *species typica*, dry.

No. 38. *Navicula serians* Kutz. × 1130, exposure 10 minutes. Showing fracture through the dots. From Moller's balsam mount of Monmouth earth (Maine).

No. 39. *Pleurosigma angulatum* W. Sm. × 1250, exposure 13 minutes. Showing marginal fracture through the dots. From Peticolas' balsam mount of Calvert Co. earth (Maryland).

No. 41. *Mastogloia angulata* Grunow. × 1015, exposure 10 minutes. Showing segment broken out with fracture through the dots and along the median line. From Peticolas' balsam mount of diatoms from Long Island Sound.

No. 44. Same species, × 1040, exposure 6 minutes. The septum separated from the valves. From Peticolas' dry mount of diatoms from Long Island Sound.

No. 46. *Pleurosigma angulatum* W. Sm. × 1250, exposure 7½ minutes. Showing marginal fracture through dots, and same on the surface where the shell has been crushed. From Peticolas' dry mount of Nottingham earth (Maryland).

No. 47. *Coscinodiscus subtilis* Ehr. var. *molaris* C. × 1130,

exposure 10 minutes. Showing crack through the dots. From Peticolas' balsam mount of Richmond earth (Virginia).

No. 50. Same as 46. × 1350, exposure 10 minutes and plate afterwards intensified with merc. bi-chlor.

No. 51. *Mastogloia angulata*, Grunow. × 1314, exposure 8 minutes and plate afterwards intensified. One side broken away, showing fracture through dots. From Peticolas' dry mount of diatoms from Long Island Sound.

SUMMARY

OF CURRENT RESEARCHES RELATING TO

ZOOLOGY AND BOTANY

(principally Invertebrata and Cryptogamia),

MICROSCOPY, &c.,

INCLUDING ORIGINAL COMMUNICATIONS FROM FELLOWS AND OTHERS.*

ZOOLOGY.

A. GENERAL, including Embryology and Histology of the Vertebrata.

Physiology of Protoplasmic Movement.†—A. G. Bourne has done considerable service to English biologists by translating Prof. Engelmann's important essay on the physiology of protoplasmic movement. Like muscular and ciliary movements, those of living protoplasm are to be regarded as phenomena of contractility. Their special character is "that the particles of the contractile mass move, as a rule, not in relation to any fixed position of equilibrium, but can change their arrangement and position (and this apparently voluntarily) as do the moving particles of a fluid substance. Further, the impulse to such movements does not normally come from without, but originates in the moving particles themselves." Protoplasm thus possesses, not only contractility and irritability, but also automatism.

Protoplasm may be doubly refractive, and different parts of a single mass may have different refractive powers. It varies in the degree of its fluidity, has great cohesive and great extensile powers, and has a tendency to form droplets; but these properties vary considerably. So again the contained granules vary in number, and, while most are albuminous, some are fatty and others inorganic. There is no chemical distinction between contractile and non-contractile protoplasm.

In the movements of naked protoplasm three chief types are to be distinguished—amœboid, streaming, and gliding. The first may be very well studied in the plasmodium of *Myxomycetes*, where the masses are large and the movements extremely rapid. When the

* The Society are not to be considered responsible for the views of the authors of the papers referred to, nor for the manner in which those views may be expressed, the main object of this part of the Journal being to present a summary of the papers *as actually published*, so as to provide the Fellows with a guide to the additions made from time to time to the Library. Objections and corrections should therefore, for the most part, be addressed to the authors. (The Society are not intended to be denoted by the editorial "we.")

† Quart. Journ. Micr. Sci., xxiv. (1884) pp. 370–418.

protoplasm is bounded by finer integuments, as in ordinary vegetable cells, we have circulation or rotation.

Under the head of "General Conditions of Spontaneous Protoplasmic Movements" there are discussed the influences of (1) temperature. The optimum temperature—or that in which the movement attains its highest velocity—is generally several degrees lower than the maximum temperature compatible with movement. While great heat is certainly fatal, protoplasm even after freezing does, in certain cases, resume its spontaneous contractions; and it is not necessary that the thawing should take place very gradually. (2) The imbibition of water has effects similar to that of temperature. There is a maximum and minimum at which spontaneous movements stop, and there is always an optimum. There may be a dry rigor, due to the withdrawal of water by indifferent or diluted solutions. In many cases the slow increase of concentration is accompanied by an accommodation of the protoplasm to the solutions. (3) Without oxygen spontaneous movements can never go on for more than some hours at the most. It is clear that living protoplasm enters into chemical union with the surrounding media, and the oxygen thus taken up is probably used for the formation of carbonic acid. (4) Poisons are next dealt with, and diluted alkalies or acids proved to be injurious. Carbonic acid, ether, or chloroform cause temporary or permanent coagulations. Like the contractile substance of muscular fibres, many kinds of protoplasm are poisoned by veratrin.

Artificial stimuli are dealt with as (1) electrical, (2) thermal, (3) luminous, (4) mechanical, and (5) chemical.

"No theory of protoplasmic movements, leading back to their elementary physical and chemical processes, can be deduced from the hitherto collected facts." As we must start with the acknowledged fact that "each smallest microscopically distinguishable particle of every contractile protoplasmic mass is capable of independent movements," it follows that "the movement as a whole is the result of changes of form of these very small elements," the nature and cause of these being provisionally undetermined. There is no reason for supposing that what we can see with the Microscope are the contractile elements themselves; these are, doubtless, molecular in size, in form spherical when excited, and elongated when not so; these hypothetical contractile elements may be called "Inotagmata." Spheres of naked protoplasm appear after excitation, and this may be explained by the simultaneous assumption of a spherical form by the inotagmata; the protrusion of processes may be imagined as due to the relaxation (lengthening) of parts of a protoplasmic mass; rotation takes place when the inotagmata of the moving layers are distributed "with their long axes parallel to the direction of the movement and a forward movement of the spontaneous stimulus takes place in this direction. The moving protoplasm creeps in this manner over the motionless cortical layer just as a snail's foot over the surface upon which it is crawling."

The author throws out some hints for further investigations into the mechanism of the changes in form of the smallest component

particles; from what we know of muscles and cilia we may assume that the proximate cause of the change of form of inotagmata is a change of their water-contents; so that the cause of contraction is a peculiar process of swelling. The further analysis of the mechanism is a question for the physicist, and the chemist must consider the problem of how the change in the water-contents of inotagmata are occasioned. "It is, however, in the present state of our knowledge, idle to express any further opinions upon the subject."

Power of Reducing Silver possessed by Animal Protoplasm.*—Dr. O. Loew in conjunction with Dr. Th. Bokorny having already shown that living vegetable protoplasm has the property of reducing silver, now extends these observations to animal protoplasm.

The excised kidneys of frogs and toads were placed in 50–100 cm. of a particular silver solution described by the author, with the ventral side upwards; after being kept in the dark for fifteen minutes it was found that the ventral surface of the gland was traversed by black lines; after a sojourn of two hours in the solution the colour was intensified and more of the kidney affected; this most striking reaction can be only seen in the living condition. It is impossible, however, to extract from the kidneys any reducing substance, though it is clear from the following experiment that such a substance must exist; the urine of six frogs was extracted by means of a pipette and placed in the dark for twelve hours with some of the silver solution; at the end of this time a number of grey specks were observed at the bottom of the vessel; these were collected and treated with ammonia, and dissolved; they imparted to the solution a dark opalescent colour as if proceeding from a feeble reduction.

In *Spirogyra*, however, where the reaction is extraordinarily intense, it could be shown by direct experiment that the oxygen of the reduced silver oxide was taken up by the albumen.

Fœtus of Gorilla.†—J. Deniker describes a fœtus of the gorilla in the fifth month. In almost every respect it approaches closely to the form of the human fœtus at the same age. The hand differs from that of the adult gorilla by the greater proportionate length of the fingers. The leg is cylindrical, without the projection of the calf evident in the human fœtus. The cephalic index is 86·2.

Influence of Magnetism on the Development of the Embryo.‡—Prof. C. Maggiorani, during the process of artificial incubation, exposed a number of eggs to the influence of powerful magnets. A similar set of eggs, being hatched in the same manner, but kept away from all magnetic action, served as a check. Cases of arrested development were four times more numerous in the first group than in the second. Microscopical examination showed that the sterilization of the germs was probably due to an intense vascularization of the yolk-sac.

* Pflüger's Arch. f. d. gesammt. Physiol., xxxiv. (1884) pp. 596–601.

† Comptes Rendus, xcviii. (1884) pp. 753–6.

‡ Atti R. Accad. Lincei, Trans., viii. (1884) pp. 274–9. Cf. Journ. of Science, vi. (1884) pp. 600–1.

After the birth of the chickens, this increased mortality continued, deaths being three times more numerous in the magnetized group. All the counter-test chickens reached their full development, whilst of the 114 of the first group, 60 presented notable imperfections. Their movements were also abnormal. There were three cases of paralysis and two of contractions.

Six of the chickens arrived at maturity. Of these, two were cocks of a splendid stature, and endowed with an insatiable reproductive appetite. With the four pullets it was quite the contrary. One of them never laid at all, and the three others generally produced merely minute eggs (the heaviest weighing only 30 grms.), without yolks, without germinal spot, and in a word sterile.

The magnetic influence upon the embryo is therefore evident, and its action upon the structure and the functions of the germ is still manifest when the latter has arrived at maturity.

"May we not, to explain this effect of the magnets, suppose an interference between the magnetic vibrations and the heat vibrations which animate the molecules of the fecundated germ, and impel them towards a new condition of organic equilibrium. This influence generally prevents, and more rarely retards, the development of the embryos (hypertrophy in the two cocks, and atrophy in the four hens), and, as interference implies analogy, may we not infer that the vibrations which impel the germ towards its development are analogous to the magnetic vibrations."

Blastopore of the Newt.*—Miss A. Johnson has, at Mr. Sedgwick's suggestion, investigated and confirmed the correctness of his supposition that the blastopore of the newt (*Triton cristatus*) does not close, but persists as the anus. While the medullary folds are wide apart, the slightly elongated blastopore is found at the hinder end of the body; it then becomes carried round to the ventral surface, and when the folds have completely coalesced, it is placed at some little distance from the hind end of the body. This blastopore is found, on making transverse sections, to communicate with a cavity in the midst of the yolk-cells, which cavity is so narrow that it is difficult to see its connection with the middle part of the gut. Behind the blastopore there is a primitive streak, which is exactly comparable with that of the Amniota; there is no neurenteric canal; the blastopore marks the extreme front end of the primitive streak on the ventral surface. The hinder part of the medullary canal is solid near its point of fusion with the primitive streak, and its lumen is gradually continued back as the medullary canal is differentiated out of the primitive streak; the relation, in fact, is just the same as in birds.

Natural and Artificial Fertilization of Herring Ova.†—Prof. J. Cossar Ewart gives a detailed account of what was previously known of the spawning of the herring and of his examination of the spawning-beds in the Moray Firth, with the following observations of the

* Proc. Roy. Soc., xxxvii. (1884) pp. 65-6.
† Ibid., xxxvi. (1884) pp. 450-61.

process of spawning under natural conditions made at the tanks in the Rothsay Aquarium.

A perfectly ripe female set free in one of the tanks was in a few minutes noticed moving slowly quite close to the bottom of the tank, with four other fish making circles around her at some distance from the bottom. Appearing satisfied with some stones which she had been examining, she halted over them, and remained stationary a few minutes about 1/2 in. from their surface, the tail being in a straight line with the trunk and the pectoral fins near or resting on the bottom. While in this position, a thin beaded ribbon was seen to escape from the genital aperture and fall in graceful curves so as to form a slightly conical mass. As the little heap of eggs increased, the males continued circling round the spawning female at various distances, while the other females in the tank remained apart. The males kept from 8 to 10 in. above the bottom of the tank, and formed circles ranging from 18 to 30 in. in diameter, with a peculiar jerking motion of the tail as they performed their revolutions. Three or four times during each revolution each fish expelled a small white ribbon of milt, which fell slowly through the water, sometimes reaching the bottom almost undiminished in size, but in most instances they had almost completely dispersed before reaching the bottom. In this way the whole of the water about the female became of a faint milky colour, and practically every drop of it was charged with sperms. Thus there is no attempt on the part of the males to fertilize the eggs as they escape from the female, but only to fertilize the water in the neighbourhood. By forming circles round the female it does not matter how the currents are running..

Various experiments were tried to bring about an artificial fertilization of herring ova, but the best results were obtained when both male and female were held under water while the milt and roe escaped, i. e. when the natural process of spawning was followed.

Development of Pelagic Fish-Eggs.*—A. Agassiz and C. O. Whitman report that they are now able to distinguish twenty-two species of pelagic eggs, which it had before been difficult to know from one another on account of their great resemblances. It has, however, been found that the pigment spots on the surface of the yolk begin to make their appearance at very different times in different species, and there is a characteristic pigment-pattern. The eggs of six species of flounders, two species of *Cottus*, of *Ctenolabrus*, *Tautoga*, *Osmerus*, and *Lophius* have been recognized. The number of eggs is very great, but the spawning seasons are comparatively short.

As, in passing from 16-cells to the 32-cell stage, the central portion of the blastodisc becomes two cells deep, it is extremely difficult to follow out the genesis of the individual cells in the living egg.

With regard to their methods the authors state that the successive phases of cleavage were first followed many times in the living egg; profile views and optical sections were obtained by tilting the Micro-

* Proc. Amer. Acad. Arts and Sci., xx. (1884) pp. 23-75 (1 pl.),

scope; "two complete series of vertical optical sections were obtained by the camera lucida, one parallel with the longer, the other with the shorter axis of the blastodisc." None of the ordinary hardening fluids were found to be successful; Kleinenberg's picro-sulphuric acid causes the cleavage products to swell, and in many cases to become completely disorganized. The best preparations of cleavage-stages were obtained with osmic acid, followed by a modified form of Merkel's fluid, 1 per cent. instead of ·25 per cent. of chromic acid being used; the eggs must be first killed by a weak solution of osmic acid. When treated with alcohol, previous to cutting sections, the egg-membrane should be broken or perforated.

The teleostean ovum affords a beautiful illustration of what Lankester has called "precocious segregation"; the mature egg is characterized by a very marked polar differentiation. The generalization of Mark that the maturation spindle always lies in the axis of the ovum may be carried further, and we may say that "it is highly probable that the first cleavage-spindle invariably lies at right angles to the axis of the ovum throughout the Metazoa; and that therefore the first cleavage-plane is always a meridian plane." The authors discuss the apparent exceptions to this law that result from the observations of other embryologists.

With regard to the observations lately made by Pflüger on the influence of gravitation, it is stated that, if an ovum be turned upside down immediately after the appearance of the second cleavage, the position of the third was not affected, as it was if the inversion was effected an hour or more before the beginning of the first cleavage; the deduction made from this is that there is a corresponding internal transposition of the active protoplasmic matrix of the ovum.

Comparing the teleostean ovum with that of the frog, the authors say "the central portion of the blastodisc represents the active portion of the pigmented hemisphere of the frog's ovum; while the marginal portion of the disk, together with the periblast ["parablast" of His], represents the active portion of the unpigmented hemisphere." The first cleavage-amphiaster was found to have a horizontal position, at right angles to the ovum.

The authors enter into some details with regard to the velocity of cleavage, and state that the early cleavages are all introduced by grooves running from the inner towards the outer surface of the blastodisc. No discussion of the nature of the nuclei is entered into, and the authors refrain from selecting any one of these possible hypotheses as to the seat of the attractive power of that region of the egg; that is, namely, whether it resides in the nuclei, in a special portion of the protoplasm intimately associated with the nuclei in the process of division, or in both. Some of the accounts given by Hoffmann are closely criticized.

The origin of the endoderm has been variously described as being from the periblast, or from delamination or invagination of the margin of the blastodisc; the authors state that they have positive proof of a centripetal ingrowth of cells from the margin of the disk; they hope to show that, contrary to the opinion of Balfour, the development of

the amphibian and elasmobranch ova furnishes nothing incompatible with this fact.

Agreement is expressed with His and Rauber in the conclusions as to the nature of the process by which the embryonic ring becomes converted into the embryo; the median plane of the embryo appears almost certainly to coincide with the first plane of cleavage. The authors think with Balfour that the neural surface is identical throughout the Metazoa. A full memoir is promised.

Cell-Division, the Relation of its Direction to Gravity and other Forces.*—E. Pflüger has recently extended his observations on the influence of various forces on the direction in which cells divide, with especial reference to the ova of Batrachia. An ovum may be regarded as a bladder filled with a fluid not uniform in consistency. The granular portions tend, under the influence of gravity, to sink, whilst the specifically lighter nucleus floats in the lighter fluid towards the upper surface. The form of the ovum, acted upon by gravity alone, will be somewhat flattened vertically, the shortest (or vertical) diameter being the "symmetric axis" which does not coincide with the primary ("non-asymmetric") axis of the ovum. The karyokinetic figures of the nucleus consist of a rearrangement of the nuclear network in a direction at right angles to the symmetric axis. Pflüger concludes that this rearrangement is in the direction of least resistance, as being entirely in the lighter non-granular portion of the cell-contents. Vertical rearrangement would have to thrust aside the heavier granular portion lying inferiorly.

To verify this view, Pflüger compressed ova between two glass plates so as to assume the form of strongly flattened ellipsoids. In 80 to 90 per cent. such ova divided after showing vertical karyokinetic spindles parallel to the surface of the glass. This result follows because the thinner and lighter fluid at the top has a greater vertical extension and the influence of gravity is no longer exerted at a disadvantage. In fact, the direction of least resistance is now vertical.

The conclusion is that under the influence of gravity, pressure, or other forces, the dividing cell rearranges its elements preparatory to division in that direction in which it meets with least resistance. On the other hand, W. Roux † and G. Born ‡ have separately come to the conclusion that Pflüger's view is not justified by facts. Roux, working with frogs' eggs, used a centrifugal apparatus and found that, whether the centrifugal force were stronger or weaker than the force of gravity, cell-division took place uniformly in the same direction, invagination occurring always on the border of the (heavier) white hemisphere and of the (lighter) dark hemisphere. Consequently, "the force of gravity is not indispensably necessary to normal development, and it has no necessary directive influence on the

* Pflüger's Arch. f. d. gesammt. Physiol., xxxiv. (1884) pp. 607–16. Cf. Naturforscher, xvii. (1884) pp. 372–4.

† Breslauer Aerztl. Zeitschr., 1884, No. 6.

‡ Ibid., No. 8.

developing ovum, occasioning its differentiation. The formal development of the impregnated ovum is a process of complete self-differentiation." Born's inquiry had a different character, and dealt with the morphological side of the problem. Pflüger had found that ova of *Rana esculenta*, if placed with the white tract superior, did not divide. Born, on the other hand, found that in the ova (of *Rana fusca*) with the white tract superior, that tract did not retain its initial position, but either entirely or in great part dipped downwards to a sub-equatorial level when cleavage commenced. In such cases cleavage commenced on whatever happened to be the uppermost side of the ovum, though not without exception. Born concludes that the question is one of indirect influence of the force of gravity acting by virtue of the characteristic arrangement and disposition of constituent parts of the ovum with their varying specific weights.

Aspects of the Body in Vertebrates and Arthropods.*—The essay of A. S. Packard is a result of Sir Richard Owen's recent study on the "Aspects of the Body in Vertebrates and Invertebrates"; its special object is to present facts against the presumed homology between Arthropods and Vertebrates. It is pointed out that histological differences are to be detected in the presence of the dotted ("myeloid") substance in Arthropod brains, and its absence from those of the Vertebrata. As to "histological topography," the ganglion-cells are internal in the Vertebrate, cortical in the Arthropod; in the latter the ganglia are at first wholly formed of spherical cells, while the differentiation into round central cells and cortical white substance is much more early effected in the former. Indeed, in no way does embryology support the doctrine of the homology of the nervous system of these two groups; and the embryos themselves are in opposite positions. The characters of the investments are altogether different.

The author regards the original dispute between Cuvier and St. Hilaire as being in part metaphysical, and he looks upon questions of this kind as savouring more of scholasticism than of science.

B. INVERTEBRATA.

Function of Chlorophyll in Animals.†—L. von Graff, dissatisfied with the conclusions of Brandt as to the symbiotic relations of what the latter regards as green algæ to *Hydra viridis*, and with the methods of his experiments, arranged three specimens of *H. viridis* in eight different vessels; four of them, A, B, E, and F, he exposed to the light; A, B, C, and D were filled with water from an aquarium. In E–G the water was filtered. In A, C, E, and G the water was changed daily, in the others it was never changed at all. The first *Hydra* to die was one in glass G, on the 31st day of exposure, in which the filtered water was changed daily, and the light shut off. The glass A did not lose a specimen till the 109th day of observation,

* Amer. Natural., xviii. (1884) pp. 855–61, and Ann. and Mag. Nat. Hist., xiv. (1884) pp. 243–9.

† Zool. Anzeig., vii. (1884) pp. 520–7.

when one died. In C, in which the aquarium water was changed daily, and light shut off, the three specimens died on the 105th, 106th, and 109th days; B, in which the water was not changed, and which was exposed to the light, only lost one specimen, and that on the 100th day.

Dr. Graff concludes that the algæ or pseudo-chlorophyll bodies of *Hydra* have no significance as means of nutrition; the fact that all the specimens in filtered water died by the 87th day seems to show that the *Hydræ* died from the want of animal food, and that the green bodies do not serve as such, as Brandt supposes. The most unexpected and perhaps the most remarkable fact is that, whether the *Hydræ* were exposed to the light or placed in the dark, they in all cases retained their green colour throughout life.

Dr. Graff has lately been able to make some observations on the rare *Mesostoma viridatum*, three out of five examples of which were richly provided with chlorophyll-corpuscles; these varied very considerably in size, and no nucleus was to be detected in the smaller specimens; starch granules of proportionate size to that of the chlorophyll-bodies were found in them. The larger green bodies were arranged in closed groups, and the smaller examples lay between the groups; most of the bodies were rounded, but a few of the larger were oval.

Action of High Pressures on Putrefaction and on the Vitality of Micro-organisms.*—A. Certes has endeavoured to solve the problem which he has already touched upon,† as to the processes and conditions by which organic matter is restored to the inorganic condition at the bottom of the sea.

In his experiments he endeavoured, as far as possible, to keep to the conditions of nature, and by a special arrangement succeeded in avoiding sudden changes in pressure. The greater number of the experiments were made at 350 to 500 atmospheres, which corresponds to the pressure of the average depths registered in the 'Travailleur' and 'Talisman' expeditions. Owing to the warmth of the season the author was not able to repeat his experiments at the mean temperature, of great depths, + 4° C., but he is able to assert that the phenomena of putrefaction are invariably produced in infusions of very different kinds, which he cultivated under pressure. In all of them, after a certain time, the liquid becomes cloudy, the organic substances, animal or vegetable, disappear, and microscopical examination reveals an abundant development of microbes. This development is, however, slower than in the open air.

The author points out certain peculiarities arising from comparative experiments—for instance, on the 13th of June two tubes with a vegetable infusion in fresh sea water were put, the one under a pressure of 350 atmospheres, the other left in the air served for control. The apparatus was inspected every day, and the pressure

* Comptes Rendus, xcix. (1884) pp. 385–8.

† See this Journal, *ante*, p. 347 (2nd note). The footnote ‡ should have contained a reference to Comptes Rendus, xcviii. (1884) p. 690.

was at first 350 atmospheres, and at the end 500. From the 26th of June the infusion swarmed with bacteria ; a further examination on the 4th and 11th of July gave the same result. The experiment was stopped on the 24th of July, the day on which the putrefaction of the vegetable tissues was complete in the control tube. This tube contained nothing but liquid and a whitish pellicle.

The tube kept under a pressure of 350 to 500 atmospheres for forty-two days, presented the same appearance, but a closer examination showed striking differences :—

Infusion under pressure.	*Infusion left in air.*
No smell, acid reaction, numerous microbes, active, generally small; rods, short and fine, with forms resembling those already described.	Nauseous odour, alkaline reaction, numerous microbes, some active, others motionless; rods generally larger than in the other infusion; long bacteridian filaments.
No special coloration by iodine.	No special coloration by iodine. Fusiform cells (yeast or mould?) Infusoria. *Pleuronema chrysalis.*

Of two tubes heated for ten minutes in a water-bath, at boiling point, one containing the liquid of the infusion under pressure, and another with the liquid of the infusion left in the air, the former was found sterile, while the latter gave abundant cultures on the following day. It therefore appears that in the greater number of cases both the chemical processes, and perhaps also the microscopic agents of putrefaction differ according as it is produced in the open air or under pressure. However this may be, the fact of the complete destruction of the organic matter by microbes which live under high pressures is, the author considers, formally established.

It is much more difficult to know what is the degree of resistance to high pressures presented by the higher microscopic organisms: infusoria, unicellular algæ, rotifers, &c. The privation of light and the progressive diminution of oxygen are so many causes of death added to the abnormal pressure. The author has, however, as already stated,* taken living Infusoria and even Rotifers and Tardigrades from the apparatus, after they have been subjected during 24, 48, and 72 hours to pressures of from 300 to 500 atmospheres. But, on the other hand, in tubes kept at a lower pressure for a much longer time there was nothing living except the microbes. Was not this result owing in great measure to the absence of oxygen ?

To satisfy himself on this head he prepared two tubes with the same infusion and put each under a pressure of 350 atmospheres, the one with a reservoir of abundant air, the other without any air. At the end of twenty-one days the aërated tube still contained a number of *Chlamydococcus pluvialis* alive and active. They were all dead in the other tube, and with the exception of the microbes, neither tube contained any other living organisms. To appreciate these facts at their full value it must not be forgotten that *Chlamydococcus* is renascent, and that it encysts itself for protection from atmospheric disturbances.

* See this Journal, *ante*, p. 547 (1st note).

Mollusca.

Operculum, and Foot-glands of Gastropoda.*—F. Houssay finds it necessary to distinguish the suprapedal from the other glands of the foot, on account of the position of their orifice, their own position, and the great complexity of structure to which they may attain. The rest, though less highly developed, are more interesting from the point of view of homology; they are typically formed of three portions, the transverse groove, the median canal, and the folded cavity, which opens on the middle of the ventral surface of the foot. By their structure, and sometimes also by their function, they are to be compared to the byssus-glands of the Lamellibranchiata; although in the latter the glands are better developed, yet they have no important additional parts. In the Lamellibranch, the glandular apparatus of the foot is essentially made up of a longitudinal ventral groove, into which there opens anteriorly a longitudinal canal which may be branched, and which stops before it reaches the byssal cavity. The interior of the foot contains a well-developed gland which uninterruptedly surrounds the small longitudinal canal, and the folded cavity. The byssus-gland appears to be formed by the union of the glands which surround the two organs, and this union may be regarded as due to the great development of these parts.

The author suggests as objections (1) that the longitudinal canal of the Gastropoda opens into the most anterior part of the foot, while in the Lamellibranchiata it opens much lower down: (2) that the canal is branched in Lamellibranchs, but simple in Gastropods: (3) that the secretions of the glands are too different to be comparable one with the other; and (4) that the transverse groove of the foot of Gastropods is suppressed and a longitudinal groove added on, in the Lamellibranch.

To these objections there seem to be the following answers:—(1) The long canal of Gastropods has an upper lip of a certain thickness; it is probable that, in Lamellibranchs, this lip has become considerably developed, or has formed the anterior portion of their foot. It is now known that this region is very generally formed of a mass of mucous glands, which are analogous, if not identical, with those which surround the transverse groove in Gastropods; these cells have not lost their muciparous function and they take no part in the formation of the byssus. (2) The reason why the canal is branched in one case and not in the other, is to be found in the fact that one has a gland much better developed than the other. (3) The difference in the secretions is no real objection; there is no greater difference between glands which secrete mucus or chitin, and those that produce chitinous or calcareous matter; and the latter obtains in the case of the byssus-apparatus. In some cases, indeed (*Venus decussata*) the byssus-gland does produce mucus. (4) There is a small transverse groove, or the representative of it, in the foot of Lamellibranchs, and the addition of a longitudinal groove is to be correlated with the greater development of the gland and its new function.

* Arch. Zool. Expér. et Gén., ii. (1884) pp. 171–288 (8 pls.).

Put shortly, the author's views are that the operculum of Gastropods is not the homologue, either of the second valve of the shell, as was thought by Gray, or the byssus of the Lamellibranchiata; it is a special production. The operculum is a calcified or horny production of the epithelium; the byssus that of a special gland. The pedal gland is, on the other hand, the homologue of the byssus-gland.

The author enters in great detail into the account of the structure of the operculum and the foot, in a number of selected types of Gastropods.

Latent Period in the Muscles of Helix.*—H. de Varigny here confines himself to an account of his observations on *Helix pomatia*, which he has studied by the aid of induced currents, applied to the two ends of the muscle of the foot. The period of latent excitation is remarkably long, and varies from 0·1 to 0·6 of a second; the period of contraction lasts much longer than in Vertebrates, and that of relaxation may extend over several minutes.

The extreme instability of equilibrium in the muscle is the next point to be noted; in other words, after removing a foot from the rest of the body of the snail one may have to wait two or three hours before it ceases to be excited by any external agent; a truly stable state is only reached when the muscle is quite or nearly dead. It is almost impossible to experiment twice successively on the same muscle in the same state; and it is quite impossible to experiment on one that has reached its maximum of extension; the experiments, therefore, that were made on the latent period of the muscle of *Helix* were made with one that was more or less contracted.

Affinities of Onchidia.†—R. Bergh, after discussing the views as to the affinities of the *Onchidia* which have been held by preceding writers, protests against the doctrine that they are nudibranchiate molluscs, and claims them as decidedly pulmonate; their nervous system does not differ essentially from that of the Pulmonata; it only differs in having the lowermost part more condensed and reduced; the ophthalmophores are like those of the stylommatophorous Pulmonata, and the pedal glands have very similar relations, as has too the digestive system. It is true that the *Onchidia* are "opisthobranchiate," but so are *Arion* and *Limax;* in this group, at any rate, the position of the heart has no systematic significance. The kidney is very like that of the Pulmonata, and the difference between the sizes of the lung-cavity is to be explained as due to the largely cutaneous mode of respiration in the *Onchidia.* The most striking proofs of relationship are to be found in the structure of the generative system; the seminal duct has a position in the lateral wall of the body, such as has never yet been demonstrated in any Nudibranch, but only in the Pulmonata. The *Onchidia* are Pulmonata which have adapted themselves to an amphibiotic or marine mode of life.

* Comptes Rendus, xcix. (1884) pp. 334–7.

† Morph. Jahrbuch, x. (1884) pp. 172–81. Cf. Ann. and Mag. Nat. Hist., xiv. (1884) pp. 259–66.

Dimorphism of the Spermatozoa in Paludina.*—It has been known for some time that the spermatozoa of this mollusc are of two kinds; the fact was originally discovered by von Siebold, and commented upon by subsequent writers. The subject has been recently studied by Max von Brunn, who contributes an elaborate paper upon the structure, function, and development of the two kinds of spermatozoa.

1. *Structure.*—The two forms are at once distinguishable by their size; the "hair-like" spermatozoa are 88 μ in length, while the "worm-like" forms are from 180–190 μ in length; the latter also are considerably thicker; the hair-like spermatozoa consist of a slender body narrowing at the "tail" into a delicate thread, and a head twisted in a corkscrew fashion for six turns; the "worm-like" spermatozoon is nearly uniformly cylindrical, and terminates in a bunch of fine cilia; the whole spermatozoon is traversed by an axial thread which commences at the base of the slightly thickened head, and terminates in the posterior bundle of cilia; a more minute examination shows that the central thread is in reality composed of a bundle of fine fibres, each one of which corresponds to a terminal cilium; the whole is enveloped by a protoplasmic sheath which forms the rest of the spermatozoon.

2. *Development.*—At first the testis cells which are to produce the two kinds of spermatozoa are indistinguishable, but later two kinds of cells are recognizable; one set divide again, and become the proper seminal cells which are to produce the "hair-like" spermatozoa; the latter are large cells which become directly modified into the "worm-like" spermatozoa. The nuclei of the cells that are to produce the latter break up into a number of small round bodies which eventually disappear, with the exception of a single one of conspicuous size which remains; at the same time a bundle of fine threads springs from the surface of the cell, close to which is the remnant of the nucleus; the bundles of threads indeed appear to take their origin from it, but this is not absolutely certain; this bunch of threads is undoubtedly the bunch of cilia already mentioned as attached to the "tail" of the spermatozoon; the nucleus to which they are attached becomes the head of this spermatozoon; the cell gradually elongates and forms the body of the spermatozoon. The formation of the "hair-like" spermatozoa is as follows:—In the ripe seminal cells the nucleus assumes the well-known spindle form and divides, division of the cell accompanying nuclear division; the first recognizable sign of the metamorphosis into spermatozoa is that the nucleus becomes homogeneous, and shows no nucleolus; in the next stage a fine thread is seen projecting from the cell, and close to the point where it is connected with the latter are several highly refracting bodies; the nucleus sends out a prolongation towards this thread, which includes the small round bodies, and which eventually becomes the middle portion of the developed spermatozoon, while the nucleus itself becomes its head.

* Arch. f. Mikr. Anat., xxiii. (1884) pp. 413–99 (2 pls.).

After describing the development of the spermatozoa, which is done in very great detail, and illustrated by numerous drawings, the author proceeds to sum up the known cases in which a similar dimorphism of the spermatozoa exists; these are *Notommata Sieboldii*, *Asellus aquaticus*, *Oniscus*, *Cypris*. The same phenomenon has been recently observed in a species of *Murex* by Schenk. The author himself records it in *Ampullaria*, and gives some description of the structure of the two kinds of spermatozoa, but was unable to find any but the "hair-like" form in other Prosobranchiata.

3. *Function*.—The question to be resolved is, What share does each kind of spermatozoon take in fertilization? Leydig previously stated that both kinds were concerned in the fertilization of the ovum, but a careful series of observations has resulted in the conclusion that only the hair-like spermatozoa penetrate the ovum; *the worm-like spermatozoa play no part in fertilization*, and their actual function is not easy to settle. It is, however, well known that in the testis of many animals, comprising examples from various groups, a great number of cells do not become spermatozoa, but increase in size and take on the appearance of ova, so that there is a kind of commencing hermaphroditism. It is possible that the "worm-like" spermatozoa of *Paludina* may be something analogous, produced by "a certain female tendency in the testis." Remembering also that the nearest allies of the Prosobranchiata are hermaphrodite, there seems nothing too improbable in imagining that they too may show an indication of hermaphroditism in their genital glands. Finally, a comparison of the structure of the testis of *Paludina* with the hermaphrodite gland of the Pulmonata shows a very considerable correspondence between the seminal cells which are to produce the worm-like spermatozoa in the one, and the ova in the other. In the hermaphrodite glands of the Pulmonata the spermatozoa and ova are developed in alternating masses; and the same is the case with the two kinds of spermatozoa in *Paludina*. All these considerations seem to show that the testis of *Paludina* and the hermaphrodite gland of the Pulmonata are very closely connected.

The author concludes this very important paper by a suggestion supported by many facts, that the Pulmonata are more nearly allied to the Prosobranchiata than to the Opisthobranchiata, as is more generally supposed.

Mode of Action of Shell- and Rock-boring Molluscs.*—Prof. F. H. Stoner considers the true explanation of the mode of action of many shell- and rock-boring molluscs to be that there is a power of osmotic dissociation, similar to that possessed by the rootlets of plants, and that it depends on the formation of chlorhydric acid through decomposition of sea-salt by certain tissues of the animals especially suited for the purpose, these tissues being kept meanwhile in direct contact with the shell or rock to be bored. In the case of shell-perforation the denticles of the odontophore would aid by

* Amer. Journ. Sci., xxviii. (1884) pp. 58–61.

removing mechanically the bits of loosened or softened shell; but the author is strongly of opinion that an acid solvent is made to act upon the shell during the process of boring.

Action of Sea Water on Molluscs.*—H. A. Coutance has experimented on the action of the salts contained in sea-water on the mussel, periwinkle, and whelk, and *Venus decussata*. As the result of these experiments, he finds that the saline elements of the sea water act very differently on molluscs, and that every modification in the composition of the water finally becomes fatal to the animals.

Their greater or less resistance depends on their organization. Bivalves resist better than spiral shells, and in these two groups the results vary according to the different species.

Salts of potash are less favourable to life than salts of magnesia, and salts of magnesia are less favourable than salts of soda. Outside of the salts dissolved in sea water sulphate of soda seems to possess a well-established preserving neutrality.

The death of bivalves is caused by a general weakening of the muscles. As the muscles can no longer draw together or open the valves, the animal is exposed to the unfavourable or poisonous action of the element.

Molluscoida.

Segmentation of Ascidians.†—E. van Beneden and C. Julin discuss the phenomena of segmentation in Ascidians and its relations to the organisation of the larva. The investigation was begun at Lervig in Norway, where the simple Ascidian *Corella parallelogramma* is very abundant and sexually mature in August and September. Since then the study has been continued at Naples—especially on *Clavelina rissoana*.

As soon as the first karyokinetic figure is formed it is possible to distinguish the sides, ends, and probably also the ventral and dorsal surfaces of the gastrula, and, consequently of the larva. The first plane of segmentation is along the median plane of the future Ascidian. At the 8-stage the materials from which the right and left, ventral and dorsal, anterior and posterior portions of the gastula are to be found, are already localized in distinct blastomeres. The ectoderm is gradually separated from the endoderm, beginning at the 8- and ending at the 44-stage. Throughout the whole period of segmentation the phenomena of cell-division proceed from behind forwards, in the sense that in all the cells the segmentation-grooves first appear on the face of the cell which looks backwards; whenever a blastomere is about to divide, two systems of concentric circles are to be seen on the surface of the cell; these may be called the antipodal systems. The inner—or polar—zone forms the most prominent, and, as a rule, very homogeneous portion of the surface. Around it there

* "Translated and published in the last report of the U. S. Commissioner of Fish and Fisheries." Original source unknown. Cf. Amer. Natural., xviii. (1884) pp. 945–8, and xvii. (1883) pp. 1079–80.

† Arch. Biol., v. (1884) pp. 111–26 (2 pls.).

is a circumpolar zone. The rays or fibrils which are inserted into the surface of the egg along the polar and circumpolar grooves form two lines, one polar and one circumpolar; the fibrils produce the cones, the apices of which correspond to the centre of attracting spheres. They form with the achromatic half-spindles a whole. When daughter-nuclei are formed and gain the surface of the blastomeres the principal cones—as the half-spindles may be called—and the antipodal systems disappear. The cause of cell-division seems to reside in the protoplasm, and the separation of the secondary chromatic disks from one another is an effect of the same kind as the appearance of the superficial antipodal systems. In a table the authors give a view of the filiation between the different cells at different stages of segmentation.

Relation of the Nervous System of the Adult Ascidian to that of the Tailed Larvæ.*—E. van Beneden and C. Julin contribute a detailed memoir upon this subject. For their investigations they made use of the larva of *Clavelina rissoana*, the earlier phase of which they had already studied.

The central nervous system is composed of (1) a cerebral vessel bearing the organs of sense, (2) a visceral portion reaching to the commencement of the tail, and (3) a caudal portion; all are traversed by a central canal dilated into a vesicle in the cerebral and further back in the visceral portion; these divisions of the nervous system are not peculiar to the larvæ of *Clavelina*, but have been shown by others to exist in *Salpa* and *Pyrosoma;* in the adult the caudal portion disappears entirely, while only a part of the cerebral and visceral portions remain; the parts that remain are those which in the fully mature larva have retained their embryonic character and are formed by a simple epithelium, i. e. the cerebral *cul de sac* and the visceral canal; the parts that are already differentiated in the larva, that is the sense-organs and the delicate epithelial wall of the vesicle together with the ganglionic mass adjacent to the floor of the visceral canal disappear.

Although nothing is known respecting the development of *Appendicularia*, there seems no doubt that the cerebral organ of that animal corresponds to the interoscular ganglion of the Ascidian and that the nervous cord traversing the tail corresponds to the caudal portion in the urodele larvæ. M. Fol, however, considers the central nervous cord of *Appendicularia* as a simple nerve.

The paper terminates with some remarks upon the formation of the branchial apparatus: it appears that the peribranchial cavities (in *Perophora*) are developed, as Kovalevsky showed, from the archenteron; in *Clavelina* these same cavities originate from the epiblast and become connected with similar outgrowths of hypoblast into which they open; this temporary condition is permanently retained in *Appendicularia;* in the adult Ascidian it is therefore clear that the peribranchial cavities are the homologues of the *endodermal* part of the branchial slits in *Appendicularia*. The development of the peribranchial cavities of Ascidians is precisely similar to that of the gill-

* Bull. Acad. R. Belg., viii. (1884) pp. 13–72 (4 pls.).

clefts in Vertebrata, and therefore the Ascidians are "Chordata with a single pair of branchial clefts while the Vertebrata are furnished with several and the Cephalochorda with a great number." The stigmata of the adult Ascidians clearly do not correspond to the branchial clefts of the Vertebrata and *Appendicularia*, but are secondary structures.

Segmentation of Simple Ascidians.*—L. Chabry's paper is supplementary to the recent important memoir of Van Beneden and Julin. His object is to show that the segmentation of Ascidians really differs but little from the regular mode, and that it is possible to approximate them to one another.

He describes the stages in which there are 2, 4, 8, 16, 22, and 30 cells; the planes parallel to the equator ("tropical planes") which, in a case of regular segmentation, lead to the succession of the 16- by the 32-stage are, in Ascidians, broken up into small parts, which do not regularly follow one another. In other words, the planes are more or less distant from the poles, and so give to the surface of the sphere an irregular appearance, which can only be brought into relation with that of regular segmentation by attentive study. The author enters into an account of his views on the subject, and expresses his belief that he has demonstrated the existence of a true comparative morphology of segmentation, the aim of which is to relate to one another the different modes of division of the yolk, and to find traits common to a number of animals in the midst of apparent irregularities.

Development of Social Ascidians.†—O. Seeliger commences with an account of the mode of cleavage in *Clavelina*, as he was not able to observe the process of fecundation, or the formation of the polar cells. The cleavage is not so regular as is ordinarily supposed, and it is interesting to note how the cleavage and the formation of the two primary germinal layers are combined in one process. Bilateral symmetry is at once observable, and a distinction into fore and hind ends appears with the 4-stage; the back and ventral aspect are seen in the 8-stage, when, too, the two primary layers begin to be differentiated.

Gastrulation commences with the appearance of 16 cells; the author does not feel able to speak definitely as to the mode of origin of the notochord; the blastopore appears to close up in much the same way as in *Amphioxus*, and the author suggests that the unaltered condition of the lower edge is due to the first appearance of the nerve-tube at this point. As the hinder portion of the body begins to increase in length, the embryo takes on a pyriform aspect, and it is in this region that the greatest activity in developmental processes is now apparent. The first organ to appear is the notochord, and its mode of formation is seen to be intimately connected with the mode of closure of the blastopore; just as in *Amphioxus* the cord extends from before backwards, and the fact that the hindermost cells are the first to become apparent, is due to the form of the blastopore. The

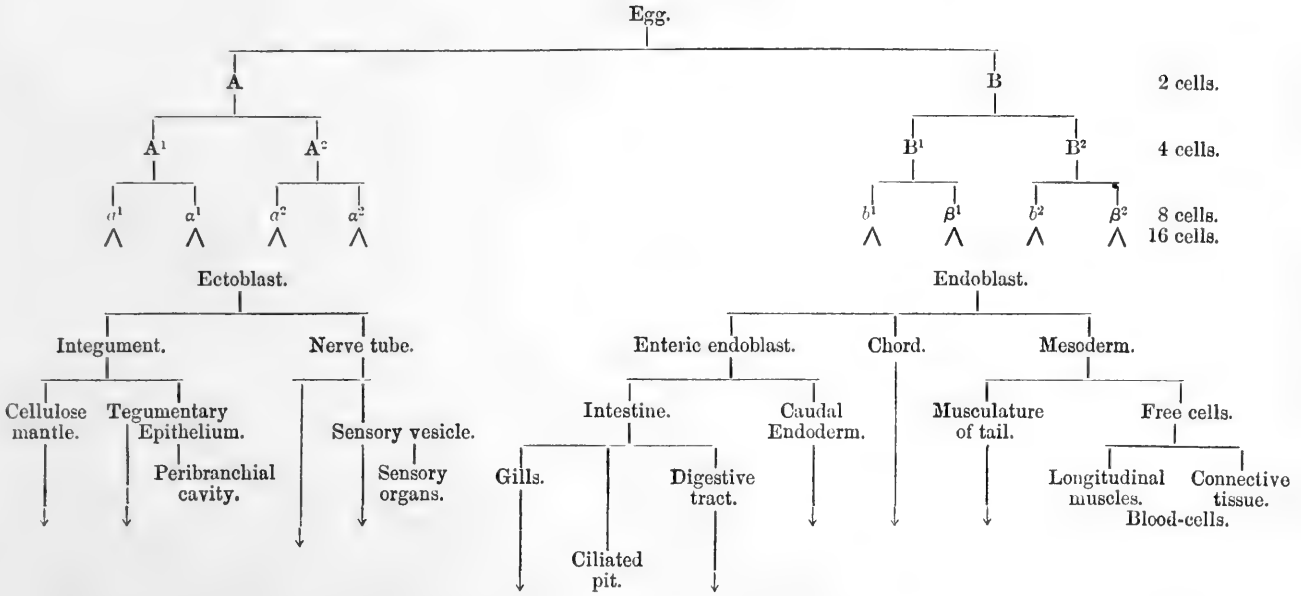
* Journ. Anat. et Physiol. (Robin), xx. (1884) pp. 387–92.
† Jenaisch. Zeitschr., xviii. (1881) pp. 45–120 (8 pls.).

mode of development of the nervous system is very closely similar to that of *Amphioxus;* the tube is for some time open at its anterior end, and in communication with the outer world. The mesoderm has a paired endodermal origin.

The fact that some of the organs begin to appear very early can, in Seeliger's opinion, only be explained by supposing that the Ascidian is derived from a more highly organized ancestral form, which was provided with a head and trunk.

The fourth period of development is distinguished as that of histological differentiation; in the fifth we have the free-swimming larva. That of *Clavelina* is more highly organized than the larva of simple Ascidians; the enteric tract is more complicated, and all the parts of the adult are to be recognized; the peribranchial cavity is, with rare exceptions, provided only with a single egestive orifice, and there are only two rows of clefts on either side; these, however, soon increase in number, and the dorsal exchange their rounded for an elongated, elliptical form. Part, at least, of the persistent musculature is formed of mesodermal cells, which had previously no function; and it is certain that the two kinds of muscles—the epithelial musculature of the tail, and the mesenchymatous muscles of the anterior portion of the body—which had been sharply separated by Hertwig, both arise from a common rudiment of mesoderm. At the end of this larval period all the organs consist of one layer, and their mode of origin may be summed up in the annexed table.

After a period of active life the larva begins to attach itself by the papillæ at the most anterior end of the stolon, so that the mouth of the animal is now turned downwards. Soon the primary axis begins to run parallel to the ground, and the mouth finally comes to lie superiorly; the communication between the cavities of the body and of the stolon becomes considerably narrower, and the stolon itself presents the greatest variations. The process of the absorption of the larval tail begins with the protrusion of the inner layers from the ectodermal tegumentary tube; the latter grows shorter, and its cells thicken. While the inner layers become spirally rolled up the few cells are set loose, as free mesodermal cells, into the circulation; the rolling up is effected gradually. What cells remain form an amorphous brown mass which, in consequence of the growth of the body, appear to pass forwards, and lie in the anterior part of the stomach. Finally, this also is dissolved, and no indication of the caudal segment is left. The whole of the nervous apparatus breaks up into its cellular elements. The growth of the young is principally effected in the direction of the long axis of the body, and in this way the plump fore-body of the larva becomes converted into the cylindrical body of the adult *Clavelina.* No indication remains, after the break up of the tissues of the tail, which would induce us to regard the Ascidian as one of the Cœlomata; the large primary cœlom is filled with free cells. The ciliated pit which early had the appearance of a canal, wide anteriorly and gradually growing narrower, has, later on, the anterior separated by a groove from the posterior part; the former widens considerably, and the canal disappears from


Egg.
A
B
2 cells.
A¹
A²
B¹
B²
4 cells.
a¹
a¹
a²
a²
b¹
β¹
b²
β²
8 cells.
16 cells.
Ectoblast.
Endoblast.
Integument.
Nerve tube.
Enteric endoblast.
Chord.
Mesoderm.
Cellulose mantle.
Tegumentary Epithelium.
Peribranchial cavity.
Sensory vesicle.
Sensory organs.
Intestine.
Caudal Endoderm.
Musculature of tail.
Free cells.
Gills.
Ciliated pit.
Digestive tract.
Longitudinal muscles.
Connective tissue.
Blood-cells.

the latter; the inner surface is not seen to be ciliated until after the fixation of the larva. The enteric tract undergoes a number of considerable changes before it attains its definite form. At the hinder end there appears a new organ—the gland which surrounds the enteron; it is formed as a diverticulum of the mid-gut, and it is possible that it has the functions of some kind of "liver." The later stages of development are, as may be supposed, those in which the gill-clefts are to be seen increasing in number.

Tunicata of the 'Triton.'*—The most interesting point in Prof. W. A. Herdman's report on the Tunicata of the Faeroe Channel is that which deals with *Doliolum denticulatum*, of which between five and six thousand specimens were collected; they all belonged to the sexual generation. The best specimens for histological study were those which had been preserved in chromic acid, and which were thoroughly washed in alcohol, stained in picrocarmine, and mounted in Farrant's solution. The test is almost absent; the first and last of the eight muscular bands form sphincters for the apertures of the body. The nerve-ganglion, which is small, gives off four large nerve-trunks, and smaller nerves between them. As in all other Tunicata, where the matter has been investigated, the nerve-cells are all in the outer layer of the ganglion, and the centre is formed of a mass of delicate interlacing fibres and granular matter. The transverse muscle-bands of the heart appeared to be composed of a large number of very fine fibres, and not of one only, as supposed by Keferstein and Ehlers.

Two glandular systems, which appeared to be quite distinct, were found connected with the alimentary canal; the first, which does not seem to have been hitherto noted, lay along the ventral surface of the stomach and first part of the intestine; it consists of cæca, which branch and occasionally anastomose; no duct or opening into the alimentary canal was detected.

Prof. Herdman asks whence all the *Doliola* have come, and where are the asexual forms from which they have been produced; the nature of the area—whether warm or cold—has apparently no influence on them, but the questions put cannot yet be answered. Mr. Missing noted that on August 5, 1882, *Doliola* were abundant, and *Acanthometræ*, which in 1881 had been present in enormous multitudes, were absent from the surface gatherings. On August 7 the conditions were reversed. The *Doliolæ* were most abundant at 5 or 6 fathoms beneath the surface; at times they appeared in vast banks, between which there were always a few stragglers; the animals were observed to be phosphorescent, and the discharges appeared to follow the direction of the nerve-cords or filaments.

Organization of Anchinia.†—N. Wagner describes a phase of the development of *Anchinia rubra* characterized by a regularly globular form of body; moreover, the long caudal appendage of the form hitherto known is wanting. This phase is agamous. Individuals

* Trans. Roy. Soc. Edin., xxxii. (for 1882-3) pp. 93–117 (5 pls.).
† Comptes Rendus, xcix. (1884) pp. 615–6.

were twice met with having a small stolon covered with buds; but this stolon differed essentially from that of the sexual form.

In addition to two pairs of very strong nerves running towards the anterior and posterior apertures of the body, the ganglion gives rise to nerves that terminate in the cells of the exterior and interior epithelium, besides others to different portions of the body. The termination of these nerves is excessively varied, giving rise to the supposition that the specialization of the organs of sense here reaches a very high degree.

Among the corpuscles of the general cavity of the body two principal types predominate, which the author calls *nutritive* or *plastic corpuscles* and *formative corpuscles*. The blood-corpuscles present only a slight modification of the former. The plastic corpuscles are believed to originate from the cells of the alimentary canal, and by their aid restoration of injured parts takes place. The formative corpuscles may in some instances reconstruct or replace the nerve terminations. The corpuscles that give rise to buds differ by their very rapid movement and by the presence in their interior of small particles of crystalline form.

Closure of the Cyclostomatous Bryozoa.*—A. W. Waters, referring to the want of characters for classifying the Cyclostomata, points out that the ovicells ought to be very carefully examined, as there are more points of importance than have so far been used; the connecting pores are also, he considers, comparable with the rosette-plates of the Chilostomata, and give by their position useful characters. Stress must also be laid on the size of the zoœcial tube, which seems to be constant in each species, whilst the position of its closure constitutes a hitherto neglected character which may possibly be of great use. The most usual position for the calcareous plate which closes the tube would seem to be about the point where this tube rises free from the zoarium. Sometimes the plate has one opening, in other species there are a number of openings, or there may be only very minute perforations, and it is apparently sometimes quite closed. Two closures quite close together are sometimes present instead of one. Its function, the author considers, may be to keep the zoœcium from being choked up by sediment during its polypideless condition.

Arthropoda.

α. Insecta.

Movements of the Heart of Insects during Metamorphosis.†—J. Künckel, attracted to the question of cardiac movements in insects during their metamorphosis, has especially studied the Syrphidæ, where the length of the period of their development and the large size of the animals offer very favourable conditions for investigation. For four days after the larvæ have lost the power of movement the heart may be still seen to be beating very regularly; the phenomenon

* Journ. Linn. Soc. Lond. (Zool.), xvii. (1884) pp. 400–4 (1 pl.).
† Comptes Rendus, xcix. (1884) pp. 151–3.

ceases to be visible when the integument is hardened and the pupa begins to be formed. In the delicate and perfectly transparent nymphs the pulsations of the dorsal vessel in the abdomen are very apparent. Later on the beatings of the heart cease completely. Again they appear, and as many as 60 per minute may be seen; the movements are now regularly performed till the appearance of the imago. It is clear then that the heart continues to beat during histolysis, and even when the phenomena of histogenesis begin to be apparent. The short period of cardiac arrest corresponds to the moment when the organ undergoes the histological modifications which are specially manifested by the formation of an aortic region.

Tracheæ of Insects.*—G. Macloskie, as the result of his researches on the tracheal organs of insects, finds that their spiral filaments are not independent structures, but crenulations or inward foldings, with thickening of the chitinous wall; that the spirals are really tubular, fissured at the line of infolding, and continuous with the inclosing wall. The function of aeration is discharged by air passing, not through the wall into the blood, but directly to the tissues by lung-like terminal cells, described by Louis Agassiz, and shown by Max Schultze to be especially abundant near the luminous organs of the glow-worm.

Light of Pyrophorus.†—MM. Aubert and R. Dubois have examined the light of the Elaterid genus *Pyrophorus*, and find that the spectrum is very fine and continuous, having neither bright nor dark bands; it extends from between the lines A and B to a little beyond F in the solar spectrum. When the brightness of the light diminishes the red and orange disappear completely; the most persistent rays are the green. When the brightness increases the order of appearance is reversed, the least refractive rays being, in other words, the last to appear. The nearest approach to this phenomenon is to be seen in phosphorescent sulphate of strontium. When the light begins to appear the central and internal regions of the organ are alone luminous; it is only when the light is very bright that it appears from the peripheral portion, and it is then only that the red rays are seen. The light has an action on sensitized paper, when about 2 centimetres from it; the chemical action is, proportionately, very intense; sulphate of calcium exposed to the light for five minutes becomes feebly phosphorescent, but no results were obtained with sulphate of quinine or a solution of chlorophyll in ether.

Sting of Mellifera.‡—G. Carlet finds that the poison-vesicle of the Mellifera has not the muscular investment which is always found in the Diploptera, that it is not contractile, and it cannot in any way act on its contents. The stylets of the sting have an organ at their base, which may be called the *piston*, and which appears to be peculiar to this group; it has a true piston action. The two stylets of the sting may move simultaneously or alternately; but, in either

* Amer. Natural., xviii. (1884) pp. 567–73 (4 figs.).
† Comptes Rendus, xcix. (1884) pp. 477–9.
‡ Ibid., p. 206.

case, each stroke of the piston forces out a drop of poison, and at the same time a fresh afflux of liquid is produced at the base. The apparatus, then, is at once aspiratory and injecting; it has the form of a syringe with a perforating canula, and by its two pistons *à parachute*, it drives out by the canula the liquid which it draws in at its base.

Anatomy and Functions of the Tongue of the Honey Bee (Worker).*—T. J. Briant minutely describes and figures the structure of the tongue of a worker honey-bee, and makes the following observations regarding its use by the insect.

If a bee be put to a large drop of honey, it will be found to open slightly the whole of the organs of the tongue, and with a scarcely perceptible motion to suck in honey, no doubt by means of the muscular pharynx. Flowers, however, do not ordinarily contain nectar in such abundance, and in order to obtain the conditions more nearly approaching those in nature the honey should be presented smeared thinly on glass. The bee will clear off every trace of honey and leave the glass clean. This is done by the bee applying the lower and outer portion of the tongue to the glass. The long joints of the labial palpi just touch the glass, the shorter joints being bent outwards at right angles. The tongue is then extended and retracted with great regularity and some speed, and to the author it appears that the extension is a somewhat slower movement than the retraction. When the tongue is in this position the "ladle" will be turned with its concave side downwards, and that surface of the tongue which is split will be upwards. The pressure on the surface of the glass will move the rod to the opposite side of the tubular portion of the tongue in that part of it which is being pressed against the glass. This will cause the two membranes to form a trough, which will of course be opened on its upper surface; and it seems impossible to the author to suppose that the honey does not pass into this trough. As the tongue is being retracted, the rod which was pressed against the inner side of the tongue will pass over to the front side, and so considerably enlarge the trough made by the membranes in the upper portion of the tongue, and the edges of the slit in the outer wall being closely united by interlocking hairs, the result will be the creation of a vacuum which will draw up the honey from the lower portion of the tongue. The tongue is then again extended; but now the salivary chamber is enlarging as the tongue is protruded, and the honey is so carried up still higher and into the mouth, whence it is once more drawn up by the muscular pharynx.

This, however, will not account for the bee being able to remove minute traces of honey. The hairs of the tongue will sweep backward the honey, that is to say, will drive it away from the mouth, towards the end of the tongue itself, and the ladle-shaped organ will then serve, as the tongue is being withdrawn, to collect and drive into the tongue the honey thus collected. When within the tongue, the capillarity of the narrow groove, assisted by the action of the salivary chamber, will

* Journ. Linn. Soc. Lond. (Zool.), xvii. (1884) pp. 408–17 (2 pls.).

afford a means, which the larger opening would not afford, of the smallest particle of honey being sucked up. These observations seem to the author to support the theory which he propounds that the honey is drawn into the mouth through the inside of the tongue by means of a complicated pumping action of the tongue itself and its closely contiguous parts, and not in any sense by lapping.*

"**Ignivorous Ant.**"†—G. Rafin describes "a species of ant which he has observed in the island of St. Thomas, and which he proposes to call *Formica ignivora*. A large fire of wood having been kindled at a certain distance from the ant-hill, he is able to affirm that the ants precipitated themselves into it by thousands, until it was completely extinguished."

Aquatic Lepidopterous Larvæ.‡—W. Müller-Blumenau has examined *Cataclysta pyropalis*, the larvæ of which live in water, but do not resemble the only known example, *Paraponyx stratiotata*, in the same way of breathing by gills. The larva, which is 1·4 cm. long, has a flattened body, attenuated posteriorly. The gills are in the form of unbranched tubular appendages of the second and third thoracic and of all the abdominal segments; they are arranged in an upper and a lower group; the number of gills varies somewhat. The stigmata of the tracheal system are, as a rule, all closed, but are easily to be distinguished by a black oval dot; just as in other larvæ with tracheal gills, as described by Palmén, the stigmatic branches are completely closed. The larvæ are ordinarily found attached to stones, and are rather more frequent in stagnant than in running water. They form for themselves a chamber with delicate but closely spun walls, and they do not leave this, as a rule, until they attain to the imaginal state. The spaces at the edge of the cocoon only serve as a means of exit for the fæces; they live on the diatoms and other unicellular algæ which grow on the stones to which they attach themselves. They almost always fix themselves by their backs to the stone, and in correlation with this we observe that they present the remarkable condition of having their dorsal surface pale, and their ventral dark. This is not, however, to be regarded as a protective adaptation, but as the result of an earlier condition in which the whole of the larva was darkly pigmented; the paleness of the back is due to the want of light.

After an account of the pupa and of the homes in which it dwells, the author passes to some other species of the same genus, all of which are Brazilian. These are much less common, and their specific characters are not yet fully worked out, but there are probably five species. The gills, which are always unbranched, never attain to the

* In this theory the author follows, though he does not quote (no doubt not being aware of it) the suggestion of J. Spaulding in Amer. Natural., xv. (1881) pp. 113–9, see this Journal, i. (1881) pp. 442–3. "In conveying the nectar from the flower to its mouth the bee probably uses the rod and sac as a suction and force-pump."

† Comptes Rendus, xcix. (1884) p. 212.

‡ Arch. f. Naturgesch., l. (1884) pp. 194–212 (1 pl.).

relative length seen in *C. pyropalis*, but they are always more numerous. The covering of the pupa contains air-spaces in its outer division, which are connected with that of the inner, but as the stones or algæ forbid any exchange of gas with the exterior, this can only be effected by the spaces in which the water is able to pass; this explains how it is that we sometimes find the air-chambers on the side of the house which is attached to the stone.

Maxillary Palp of Lepidoptera.*—A. Walter has made an examination of the maxillary palp in one hundred and one species of Lepidoptera, of which he gives careful accounts. This palp is found in a series of stages of reduction, from the lowest forms of the Microlepidoptera to the Rhopalocera; at one end, in *Micropteryx*, we find it with as many—six—joints as in any insects, and in *Lycæna*, at the other end, there is no sign of it. It follows from these observations that there is no number of joints which is characteristic of the whole order as has been supposed by Burmeister; on the other hand, the maxillary palp has always a constant number of joints, the same position and the same appendage in a given species; there does not appear to be any sexual dimorphism. On the whole, then, it is an organ of considerable value in the determination of the affinities of genera.

All the lower orders of insects with which it is reasonable to connect the Lepidoptera have a well-developed maxillary palp, of from four to six joints. The author gives a table of the groups of Lepidoptera, starting with the Microlepidoptera, and showing that the three-jointed Nocturna have given off forms with two joints or one; the Geometra, Sphingidæ, and Hesperidæ have one.

Development of Viviparous Aphides.†—O. Zacharias differs in some points from Metschnikoff who in 1866 investigated the subject of the development of the Aphides. Some of the errors of the earlier observer are attributed to his failure to use the "method of rolling" by means of which we may get different aspects of the embryo. In the mature embryo two retort-shaped bodies are to be seen on each side, and not one as Metschnikoff reported; the result of this discovery is, for the first time, to bring the parts of the mouth of the Aphides into homology with the corresponding organs of other insects; for their retort-shaped bodies result from the modification of the mandibles and maxillæ. In addition to the "procephalic lobes" of Huxley there is a median plate which is produced from the ventral part of the cephalic hood; the author proposes to call it the mandibular plate; he thinks that Huxley mistook the cephalic for the abdominal end of the body. The brown masses of substance which in *Coccus hesperidum* correspond to the secondary vitellus of *Aphis rosæ* were distinctly seen to form two long cords which open into the rectum; they are the Malpighian vessels. A full memoir is promised.

* Jenaisch. Zeitschr., xviii. (1884) pp. 121–71.

† Zool. Anzeig., vii. (1884) pp. 292–6. Cf. Ann. and Mag. Nat. Hist., xiv. (1884) pp. 54–6.

Systematic Position of Pulicidæ.*—K. Kräpelin finds that there is a certain parallel between the buccal organs of the fleas and of the higher Rhynchota, while their other anatomical characters show that the fleas are less closely allied to the Diptera than to the Rhynchota; they cannot, however, be placed with them in the same order, and it is necessary to form a separate division, for which Latreille's name of Siphonaptera may be used; their sucking tube is formed by a dorsal and two lateral channels (labrum and mandibles), the anterior portion is alone inclosed laterally by the multiarticulate palpi of the labium, and, at the base, besides the latter, by the lamelliform palpigerous maxillæ. While in both Diptera and Rhynchota the efferent salivary duct is unpaired, there are two in the Siphonaptera; there is no sucking stomach, or pair of halteres as in the Diptera, there are no wings, as there may be in the Rhynchota; there are no facetted eyes, as in the Diptera, but the metamorphosis is complete whereas it is usually incomplete in the Rhynchota.

γ. Arachnida.

Development of Spiders.†—W. Schimkewitsch's chief results are as follows:—The cells produced by the cleavage of the egg do not all form pyramids radiating outwards from a central cavity; some remain within the latter and fill it up; each "pyramid" contains several protoplasmic masses and is homologous with a polynuclear cell; each pyramid, as Ludwig has shown, is separated into two layers, one forming the primitive ectoderm, the other the primitive endoderm. The cells of the ectoderm collect into a mass on the ventral surface of the egg, the cumulus primitivus; later the mesoderm arises from a region of the ectoderm which corresponds to the primitive streak; in front of the cumulus is the blastoporic aperture; the mesoderm arises from the endoderm as well as from the ectoderm. The mesenteron is at first a closed sac, its cavity filled with the primitive endoderm cells; two ingrowths take place into the mesenteron dividing it into two cavities; the upper of these is the cavity of the heart, the lower that of the mesenteron in a more restricted sense; the blood-corpuscles are partly endodermic and partly mesodermic; and in the adult there are two forms of blood-corpuscle. The aorta is formed by a cutting-off of the dorsal section of the gut.

With regard to the appendages, the upper lip is derived from two rudiments erroneously described by Kronenberg as antennæ; the lower lip similarly arises in two portions. Both unite to form the rostrum which corresponds to that of the Pycnogonida. The nervous system originates as two distinct cords from the ectoderm, these approach each other and include an invagination of the ectoderm, which, however, plays an unimportant part in the formation of the nervous system.

* Festschrift z. 50-jähr. Jubiläum d. Realgymnasiums d. Johanneums, Hamburg, 1884. Cf. Ann. and Mag. Nat. Hist., xiv. (1884) pp. 36–53 (1 pl.).

† Zool. Anzeig., vii. (1884) pp. 451–3.

Anatomy of Spiders.*—Dr. M. Bertkau deals principally with the anatomy and histology of the digestive tract which is described in some detail; the various glands in connection with the alimentary system are also treated of, and there are some interesting notes upon the so-called coxal glands which have lately been described by Lankester in the king crab; these glands were erroneously supposed by Wassmann and others to be salivary glands, but it appears that they have in reality no relation to the digestive system. In *Atypus* the coxal gland of either side extends from the hinder end of the cephalothorax as far as the base of the first pair of legs, and is imbedded in the lateral prolongations of the endoskeleton between its two upper wing-like processes; the posterior extremity of the gland is prolonged into the fourth pair of legs together with the stomachal diverticulum; there is, however, no aperture uniting the two. The whole gland is covered by a layer of longitudinal and transverse fibres which unite into a cup-like structure attached to both body walls between the dorsal surface and attachment of the legs; the gland tissue projects for a short way into these cup-like structures; the gland itself is much coiled within its sheath. In the group of the Tristicta the gland forms a simple tube not at all coiled. No external aperture was discoverable in adult examples, but in young specimens of *Atypus* the gland was found to open on to the exterior between the dorsal part of the integument and the base of the third pair of legs. The coxal glands are clearly a rudimentary organ and since their secretion is cast out on to the exterior of the body, they are excretory organs in the wider sense of the word. Perhaps the prolongations of the gland towards the exterior, already referred to, are indications of a metameric arrangement, in which case its analogy with the "segmental organs" becomes more conspicuous. The disposition of the coxal glands has some bearing upon the classification of spiders; the fact that they are always comparatively complicated (through folding) in the Tetrasticta seems to show that this group is a natural one; and in the same way the Tristicta all agree in having a simple unfolded coxal gland. Since the gland must be considered as a rudimentary organ its less complexity in the Tristicta indicates that the group should be placed lower in the system than the Tetrasticta.

Anatomy of Epeira.†—W. Schimkewitsch gives a detailed account of the anatomy of this spider. After a brief historical introduction the author describes in order the various organs of the body, comparing their structure with that of other Arthropoda. The eyes, previously investigated by Grenacher and Graber as well as others, are described, and the results given tend to show that Grenacher's description is more accurate than Graber's; the dimorphism of the eyes discovered by the first observer is remarked upon; the study of the central nervous system and its branches shows that the "antennæ" of insects are not represented in spiders; the rostrum in spiders corresponds to the

* Verh. d. Naturhist. Vereins d. Preuss. Rheinlande u. Westfalens, xli. (1884) pp. 66–77.

† Ann. Sci. Nat. (Zool.), xvii. (1884) 94 pp. (8 pls.).

labrum of insects and the cheliceræ of the former to the mandibles of the latter. The circulatory as well as the muscular system approaches that of *Limulus*, but the resemblance is to be explained, not by community of descent, but by the general similarity of shape. The presence of a sac-like pericardium, the walls of which are continuous with the pulmonary veins, recalls the dispositions met with in Crustacea where the branchial veins are similarly prolongations of the pericardium; but this identity probably results from the disposition of the respiratory organs, which in both groups are localized on the lower surface of the abdomen. That this explanation is just, seems to be proved by the fact that in the Opilionidæ, where only tracheæ are present, the heart is not furnished with a pericardium.

Spiders are furnished with "lungs" as well as tracheæ, while in the scorpion only the former kind of respiratory organ is present; the Opilionidæ as well as the Acarinæ have only tracheæ. Schimkewitsch disputes the opinion of Milne-Edwards that the lungs of scorpions are comparable to modified branchiæ of *Limulus* and suggests rather that they have been formed by coalesced bundles of tracheæ, such as are to be found in many caterpillars; he considers, however, that the ancestors of both scorpions and mites breathed by means of "lungs" and that the tracheæ of the mites are a more modern development. In no case do the respiratory organs of spiders show any resemblance to those of *Limulus*.

The generative organs show a great likeness to those of the Pycnogonida. The genital glands in both groups are in the form of a U, and situated above the intestine; the position of the ovaries in the legs in the Pycnogonida is quite secondary; moreover, there is a general correspondence in the appendages; the rostrum of the Pycnogonida is entirely comparable to the upper and lower lip of spiders, while the mandibles correspond to the cheliceræ. In support of this homology it is stated that the cheliceræ in some spiders, at any rate at a certain stage of development, are composed of three joints as are the mandibles of the Pycnogonida. The four pairs of legs are quite similar in the two groups, and the palpi also. With regard to the ovigerous limbs of the Pycnogonida, it seems at least probable that they are the maxillæ of the spider. In fact these two groups have probably descended from a common ancestor; the Pycnogonida being in some respects arrested in development (articulate mandibles, free thoracic segments) and in other respects modified (rudimentary abdomen).

Auditory and Olfactory Organs of Spiders.*—F. Dahl proposes to classify spiders according to the character and disposition of the auditory hairs on the limbs of these animals, as follows:

1. Tibia with two series of auditory hairs, metatarsus with one hair, and tarsus with a rudimentary pit or depression free from hairs: e. g. *Epeiridæ*, *Uloboridæ*, *Theridiidæ*, and *Pholcidæ*. 2. Tarsus with no rudimentary depression for auditory hairs, usually

* Arch. f. Mikr. Anat., xxiv. (1884) pp. 1–10 (1 pl.). Also transl. in Ann. and Mag. Nat. Hist., xiv. (1884) pp. 329–37 (1 pl.).

bearing a number of hairs like the metatarsus and tibia: e. g. *Territelariæ*, *Dysderidæ*.

The remaining members of this class are further subdivided according to the presence of one or two series of auditory hairs on the tarsus. A single series is characteristic of *Amaurobiidæ*, *Agalenidæ*, *Philodromidæ*, *Thomisidæ*, and *Attidæ*. Two series occur in *Drassidæ*, *Anyphænidæ*, and *Lycosidæ*.

Dahl has satisfied himself that these auditory organs can appreciate not only sound, but also variations of atmospheric pressure, such as winds.

An olfactory organ is stated to exist on the maxillæ. On the surface in front of which the mandibles work to and fro is a soft flat tract, of a sieve-like appearance, beneath which occur a number of long, polygonal processes, apparently fused, but in reality separate, which are in connection basally with a stout nerve-filament. Rather by a process of exhaustion than from direct evidence as to their function, Dahl affirms that this organ is olfactory in nature. It is universally found in Arachnida, though in different stages of development, being most fully developed in *Pachygnatha*.

Anatomy of Pentastomum protelis.*—W. E. Hoyle gives a detailed account of the anatomy of a new species of *Pentastomum* (*P. protelis*) from the mesentery of *Proteles cristatus*. The most interesting fact relates to the condition of the male sexual organs; the vas deferens passes down as far as the vesicula seminalis, and comes into actual contact with it, though no communication between the two existed; this is in harmony with Leuckart's discovery that the generative organs of *Pentastomum* are formed of two distinct portions: (1) a mass of cells segregated from the general tissue of the embryo, and (2) an external invagination; it is probable that in the species described, the junction between these two portions takes place at the point where the vas deferens comes into contact with the vesicula seminalis, and it is not a little remarkable that this species should present such a striking embryonic feature when the remainder of its organization has attained such a comparatively advanced stage of development.

The paper concludes with some remarks on the subdivision of the family Pentastomidæ; and the author is of opinion that the two genera *Linguatula* and *Pentastomum* ought to be separated, and gives the following definitions:—

Linguatula. Body flattened; body-cavity sending out lateral processes into the annuli; hook gland diffuse; opening of œsophagus into the extremity of the intestine; testis double; vesicula seminalis single.

Pentastomum. Body cylindrical; body-cavity even, without lateral prolongations; a hook gland on either side of the intestine; testis unpaired; vesicula seminalis single (?)

F. Jeffrey Bell† suggests that this is the immature stage of *P. polyzonum* which is found in large snakes.

* Trans. Roy. Soc. Edinb., xxxii. (for 1882–3) pp. 165–93 (2 pls.).

† Ann. and Mag. Nat. Hist., xiv. (1884) pp. 92–3.

Pycnogonids of the Faeroe Channel.*—P. P. C. Hoek describes the Pycnogonids dredged by the 'Triton' in 1882. Eleven species were collected, one of which, *Pallenopsis tritonis*, is new. The cold-area species found in the Atlantic occur also in the Arctic Ocean; one species, *Nymphon longitarse*—does not appear to have its distribution determined by the temperature of the water it inhabits. Within the limits of the genus *Pallenopsis* there are species with three-jointed, and others with two-jointed mandibles; the former are of the more ancient type, as is shown by their condition in *Ascorhynchus* and *Colossendeis*, where, being larval or rudimentary, they have not been strongly influenced by circumstances, and so retain their original number. The original condition is seen in the deep-sea species, while the shallow-water forms have two-jointed, and more robust, mandibles. While *Nymphon stroemi* has a number of small eggs, *N. macrum* has a few in each egg-mass, and these are large.

Development of Limulus.†—J. S. Kingsley begins his account after the formation of the blastoderm. At this time there is a single layer of cells surrounding the yolk, in which are scattered nuclei. The mesoblast arises as a single sheet on the ventral surface. Its cells come largely from the blastoderm, but some arise from the yolk nuclei. The mesoblast soon forms two longitudinal layers, one on each side in the neighbourhood of the limbs. The cœlom is formed by a splitting of the mesoblast, and at first consist of a series of metameric cavities extending into the limbs. The supra-œsophageal ganglion arises by an invagination of the epiblast. The heart arises as two tubes in the somatophore, which later unite. The mesenteron does not appear until after hatching. The amnion of Packard is the first larval cuticle, and bears a resemblance to the amnion of the Tracheata. A second cuticle is formed and moulted before hatching. The eyes appear on the dorsal surface at the same time that the limbs appear on the ventral. In these characters *Limulus* agrees essentially with the Tracheata, and has nothing in common with Crustacea.

δ. Crustacea.

Rate of Development of Carcinus mænas.‡—G. Brook has for more than two years been making observations on the rate of development of the common shore-crab, and every cast shell has been carefully preserved and labelled. Only one ecdysis was observed to occur between the end of October and the beginning of February, and the majority of ecdyses happen in the summer months. It appears to be impossible to judge the age of any particular specimen or the number of ecdyses which it has passed through from a casual observation of it on the sea-coast. Two given forms ("A" and "B") might, two years after hatching, be one 28 mm. long by 35 mm. broad, and the other 45 by 56 mm. Mr. Brook points out that it is probable that in confinement young *Carcini* do not develope with exactly the same rapidity

* Trans. Roy. Soc. Edinb., xxxii. (for 1882–3) pp. 1–10 (1 pl.).
† Science Record, ii. (1884) pp. 249–51.
‡ Ann. and Mag. Nat. Hist., xiv. (1884) pp. 202–7.

as in their natural haunts; his careful observations of dates and measurements are, however, of considerable importance. He observed a more rapid change from the larval to the true Brachyuran form than that gradual alteration described by Spence Bate in his classical paper on the Development of Decapod Crustacea.

'Challenger' Isopoda.*—F. E. Beddard gives a preliminary notice of some of the Isopoda collected during the voyage of H.M.S. 'Challenger.' Sixteen species of *Serolis* were dredged, nine being new species. Four are deep-water forms, the remaining new species having been dredged in shallow water off the coasts of S. and E. Australia. The geographical distribution of *Serolis* is "limited and peculiar," being almost entirely confined to the Antarctic hemisphere. The deep-sea forms have a wider range than the shallow-water species, although none have as yet been found north of the equator.

The differences noted between deep- and shallow-water forms occur (1) in the epimera (especially the 6th pair) which are much more elongated in the deep-water forms than in other, and (2) in the eyes.

In deep-sea forms of *Serolis* Mr. Beddard found that no veritable retinula was ever developed. A vitreous body is represented, and the cornea may, or may not, be facetted. In shallow-water forms, on the other hand, the eyes are invariably well developed, and resemble those of other Isopoda. These facts are interesting as bearing on the theory of "abyssal light," the presence of eyes in the deep-sea forms (one of which was dredged from 2040 fathoms) serving to enable these animals to perceive the light emanating from phosphorescent Alcyonarians. Fuller details will appear in the forthcoming 'Challenger' Memoir on the Isopoda, now in the press.

The Cryptoniscidæ.†—R. Kossmann first directs himself to the question of the relation of the sexes in these parasitic Isopoda and comes to the conclusion that the mature males retain their larval form and have swimming feet on the pleon; the f male, however, is not fertilized until it has passed through a metamorphosis, and become fixed and greatly degenerated. This is not, at the same time, the whole of the story: Kossmann is convinced that both forms are only the developmental stages of one and the same individual: in other words, the Cryptoniscidæ exhibit protandric hermaphroditism; and so far remind us of what obtains in the allied Cymothoidæ.

The chief part of what remains of the digestive apparatus after degeneration appears to be the homologue of the so-called liver of the rest of the Crustacea; but it has not a hepatic function, its lumen receives the food of the parasite, which is identical with the blood of the animal on which it is parasitic; the food is here digested and absorbed. The "liver" of other Crustacea is likewise not a hepatic organ, the name was erroneously given to it on account of its coloration. Hoppe-Seyler and Krukenberg have discovered in it ferments which have a diastatic, a peptic, a tryptic, and a fat-reducing property, and M. Weber has applied to the organ the name of hepato-pancreas;

* Proc. Zool. Soc. Lond., 1884, pp. 330–41.

† SB. K. Preuss. Akad. Wiss., 1884, pp. 456–73.

Frenzel, however, has shown that it has no biliary constituents. Kossmann calls it a *glandula intestinalis* or *intestinum glandulum*, and regards it as a reservoir of enteric function with a secreting, and at the same time, absorbing epithelium. Sections of the hind-gut reveal a lumen which is stellate in form, owing to the projection of papillæ into it. The fat-body appears to undergo early degeneration, and the renal masses which it contains in the earlier larval stages disapppear; with this change we probably have to correlate the altered mode of obtaining nutrition. The author is unable to give any evidence as to the production of a highly odorous substance by the rectal vesicle, on which Fraisse has reported; on account of the feeble development of his own olfactory sense.

Antennary Gland of Cytheridæ.* — W. Müller-Blumenau has discovered that *Elpidium brossoliarum* is able to secrete a sticky material, while in water; the observations made in connection with this discovery led him to the belief that the animal was able to spin, and that the spinning organ was placed in the second pair of antennæ. The organ so well known to be present at the base of this pair of appendages has been supposed to be poisonous in function, but no direct observations have ever been made in support of this view, and it is opposed by the delicate nature of its flagellum, which could never be supposed to be capable of inflicting a wound. When the animal is found hanging to glass its anterior end is always nearest to the glass, and the creature takes an oblique position. The author points out the difficulties presented by the habits of the animal in determining the question which he has investigated, but it would seem to be certain that the antennary gland is possessed of the power of secreting an attaching thread.

'Challenger' Cirripedia.†—Dr. P. P. C. Hoëk, taking Darwin's Monograph as a basis of departure, gives (1) a sketch of the development of our knowledge with regard to the number of the genera and species of Cirripedia known, their geographical and bathymetrical distribution; (2) a summary of what has been added to our knowledge of the anatomy, embryology, &c., of the group; and (3) a discussion of the different opinions published with regard to the classification of the group, especially since the discovery of the so-called Cirripedia Suctoria or Rhizocephala.

Out of 78 species of Cirripeds represented in the 'Challenger' collection only 19 had been previously recorded, and 59 are named and described now for the first time. In 1854 Darwin gave the number of known Cirripeds as 147, and since then only some 18 new species have been recorded. Of the 34 genera of Cirripedia at present known the species of 28 have never been observed at a depth greater than 150 fathoms. Two have been found from the shore to 400 fathoms (*Alepas* and *Pœcilasma*). *Balanus* occurs from the shore down to 510 fathoms. *Dichelaspis* ranges down to 1000 fathoms; and finally only two genera

* Arch. f. Naturgesch., l. (1884) pp. 213–6.

† Report of the voyage of H.M.S. 'Challenger.' Zoology, viii. (1883) 169 pp. (13 pls.).

(*Scalpellum* and *Verruca*) have been observed at depths greater than 1000 fathoms. The occurrence of these two latter genera in the greater depths of the ocean coincides in a striking manner with their palæontological history, but Dr. Hoëk has not been able to identify any of the recent species with the extinct forms described by Darwin, Bosquet, and Reuss.

Of the genus *Scalpellum* only 11 species were known up to the cruise of the 'Challenger'; over 40 species were added to the list as the result of the cruise. The majority of the species are inhabitants of deep water; indeed *Scalpellum* appears to be the only genus of the stalked Cirripedia which is to be often met with at great depths. It is also worthy of note that the observation of Darwin made with regard to the number of specimens of Cirripeds during the Cretaceous period may be made for the recent species of *Scalpellum*: "The number of species is considerable, the individuals are rare." While the species found during the 'Challenger' cruise amounted to 43, 26 of these are represented by a single specimen only; 4 are represented by 2 specimens; 5 by 3; 2 by 4; and only 6 species are represented by more than 4 specimens. The study of the complemental males found in some of the species of *Scalpellum* has given some very interesting results, but we are promised a more detailed treatment of the organization of these little creatures in a supplementary memoir, which will deal with the anatomy of the group. The largest species of the genus known has been called *S. darwinii* and only a single specimen was dredged.

Of the genus *Verruca*, 10 species, of which 6 are new, were found. They are among some of the most interesting forms of animal life collected during the expedition, and proved that the number of recent species is much greater than had been to this time supposed to exist, and that the genus has a true world-wide distribution. Of the six stations which yield *Verruca* one belongs to the Northern Atlantic, three to the Southern Atlantic, one to the Pacific, and one to the Malay Archipelago. By these discoveries the range in depth has been immensely increased; the greatest depth known to Darwin for *V. strömia* O.F.M. was 90 fathoms, but the six new 'Challenger' species inhabit depths of from 500 to 1900 fathoms. Of the genus *Balanus* 9 species are referred to, and 5 described as new; and of the genus *Chthamalus* 1 new species is described.*

Vermes.

New Pelagic Larva.†—J. W. Fewkes points out that before any intimate connection between the Vermian and Polyzoan phyla can be satisfactorily made out, a larger number of intermediate larval forms of one group or the other must be found. Such a larva, which seems to him to fill in part the gap in our comparison of the larval Annelid and the young Polyzoan, he has taken several times, and although at present ignorant of the adult form which it attains, it seems of more than

* See Nature, xxix. (1884) pp. 522–3 (1 fig.).
† Amer. Natural., xviii. (1884) pp. 305–9 (4 figs.).

ordinary interest as having to a greater extent than any known larva, characteristics of the young of both the group of Chætopods and that of the Marine Polyzoa. Of all known worm larvæ it has the closest likeness to *Mitraria*. It is, however, still very far removed from it in many points of structure. The Polyzoan larva which it approaches most closely is *Cyclopelma*, the young of *Loxosoma*. It has many affinities with *Cyclopelma* as well as with *Mitraria*, and seems intermediate between the two.

A detailed description with four figures is given, and it is pointed out that it has one highly characteristic Polyzoan feature. The ciliated belt is reflexed over the lower half of the body in the same way that a homologous structure is turned back in *Cyclopelma*. The spines appended to the posterior region of the body are probably temporary, and are homologous with the embryonic setæ in *Spio*, *Prionospio*, and several other genera. They approximate nearer the setæ of *Mitraria* as far as position goes, although they are not mounted on any special prominence, and arise from the posterior body region which bears the terminal ciliated prominences. In *Mitraria* there are no eye-spots similar to those which have been described in the new larva. In the young *Loxosoma* there are two well-marked ocelli.

As only a single stage in the development was found, while there is no doubt we have a larval Annelid, it is impossible to say to what family of Chætopoda it should be referred.

Head-Kidney of Polygordius.*—J. Fraipont confirms the greater number of observations of Hatschek on this simple Annelid, and adds to them the results of his studies on a new species, *P. neapolitanus*. The secretions noted by Hatschek are considerably larger in the new species and resemble drops of fat. When the organ attains its highest degree of development there are ordinarily two infundibula at the extremity of the vertical branch and three at the end of the horizontal branch of the organ. In some larvæ a third branch is to be detected, at the end of which there are one or two funnels. There appears to be a considerable amount of variability in the number of the funnels, and, consequently, in the general appearance of the organ. Fraipont finds that the excretory canal is not in direct communication with the body-cavity by the intermediation of the funnel. The radiating sides which support the infundibular membrane are hollow canaliculi which terminate blindly at their free end and open behind into a polygonal space which is only in relation with the lumen of the excretory canal. These canaliculi vary greatly in number—from three to six; they may be straight or curved in various directions.

The excretory infundibula of the larva of *Polygordius* do not seem to have any close or real resemblance to those of Rotifers, Trematodes, or Cestodes; the large excretory canals correspond phylogenetically to the large canals of these forms, the canaliculi which end blindly represent the remnant of the system of canals of the second order which are found in many Rotifers, and in nearly all Platyhelminths; the fine canaliculi of the latter are not found in Rotifers, while the

* Arch. Biol., v. (1884) pp. 103–10 (1 pl.).

true infundibula of Rotifers and flat-worms are never developed at all in *Polygordius;* the infundibula of this Annelid are, rather, homologous with a part of the excretory canaliculi. The comparison of the transitory head-kidney of the larva of *Echiurus* with that of the larva of *Polygordius* is very instructive, and the only differences lie in the fact that in the former the fine canaliculi are not connected by a membrane, and that these are remnants of the terminal infundibula. The author hopes he has rigorously identified the corresponding parts of the head-kidney in *Polygordius* and *Echiurus* with the excretory apparatus of Rotifers and Platyhelminths. He states, in conclusion, that his results have been independently confirmed by Dr. E. Meyer, who is working at Naples.

Nervous System of the Archiannelidæ.*—J. Fraipont publishes some interesting facts concerning the structure of the central and peripheral nervous systems in the three genera *Polygordius*, *Saccocirrus*, *Protodrilus*.

In all the Annelida proper, the central nervous system, though originating in the ectoderm, becomes subsequently disconnected with it and separated by the muscular layers of the body-wall. In *Protodrilus* it retains its embryonic position, and is not even separated by a membrane from the circumjacent epidermis; the cells found on the lower surface of the nerve-cord are but little differentiated and pass gradually without any break into those of the epidermis. The central ganglia, however, are surrounded by a special sheath, but like the ventral cord lie in the epiderm itself. In *Polygordius* the two halves of the ventral cord are united closely together as in the higher Annelids, otherwise they are arranged as in *Protodrilus*, the cerebral ganglia are divided into three regions, two anterior, one median, and two posterior ganglia. They are covered by a delicate membrane which isolates them from the epidermis within which they lie and from each other. The anterior ganglia supply the tentacles and the posterior the ciliated fossæ. In *Saccocirrus* the nervous system is in the same rudimentary condition; the cerebral ganglia are more condensed and not isolated as in *Polygordius*. In all three genera a rich nervous plexus lies within the longitudinal muscles of the body-wall, which is in connection with the ventral chain as well as with certain of the superficial epidermic cells. The paper terminates with a discussion on the origin of the nervous system in Annelids and its relation to that of *Chætognatha*.

Anatomy of the Hirudinea.†—A. G. Bourne bases his memoir on the study of forms belonging to ten genera.

Under the head of external characters he addresses himself to the question, How far in the series of Hirudinean genera do external characters express the metamerically segmented nature of their organization? He takes as an example *Pontobdella muricata*, and describes the internal and external characters of a normal somite;

* Bull. Acad. R. Belg., viii. (1884) pp. 99–120.

† Quart. Journ. Micr. Sci., xxiv. (1884) pp. 419–508 (11 pls.).

Branchellion and the extreme form *Hirudo* are next discussed; the first and last are almost identical in their external characters.

The cells of the epidermis may become glandular or sensory; the former are either superficial and mucous, or more deeply seated, when they may be salivary, clitellar, or prostomial; the functions of these last stand in need of further investigation. The muscular system is next described, and its cells stated to be very long, and in some cases much branched; there is a cortical layer which, in transverse section, is seen to exhibit longitudinal fibrillation, and a granular medullary substance with a large oval nucleus. The connective substance differs in the extent of its development in different genera, and the amount of it is in direct proportion to the "limpness" of the leech. The cells of which it consists undergo ento- or ecto-plastic metamorphosis; in the former case the cell retains its rounded form, and we may have vacuolated cells, or fat-cells; the most common representatives of the latter are the elongated or branched corpuscles, which can be easily studied in *Hirudo*, though best in *Pontobdella*. A third case is called that of ect-ento-plastic metamorphosis, and here the cell developes pigment; in the simpler conditions the cells take no part in the formation of a vascular system (Rhyncobdellidæ); in the Gnathobdellidæ the cells take part in the formation of a vascular system, botryoidal tissue, vaso-fibrous tissue; the mode of development is best studied in *Aulostomum*. Vacuolation to form capillaries is a mode of entoplastic metamorphosis. It is found that all the forms of connective and vasifactive tissue may be derived from an indifferent connective-tissue corpuscle. The phenomena they exhibit lead on to the general question, Is there any well-founded distinction to be drawn between spaces in the animal body with regard to their relations to the cell or cells surrounding them?

Mr. Bourne points out that some of the spaces in the animal body, for example, the contractile vacuoles of Protozoa, the ducts in the nephridial cells of leeches, and so on, are obviously formed by actual metamorphosis of the cells themselves, and are to be contrasted with such spaces as the lumina of invaginated gastrulæ, which are formed outside cells; we may, then, distinguish between endocytic and paracytic cœlosis. Both these processes of lumen formation (cœlosis) may be direct, the lumen appearing at once, or indirect, the appearance of the lumen being delayed.

The single vascular fluid of the Hirudinea corresponds to both cœlomic and red vascular fluids as found in the Chætopoda. In the Rhyncobdellidæ the blood is colourless, in the Gnathobdellidæ it is red, the plasma containing dissolved hæmoglobin. The author enters in great detail into the characters of the cœlomic spaces, and prefaces it by saying that by the word "cœlom" he understands "a space or set of spaces excavated in the mesoblast and distinct from blood-vessels, such as is the body-cavity of Chætopoda and Vertebrates," and he does not "undertake to discuss whether such space is a pseudocœl or an enterocœl in the Hertwigs' sense, or may be something altogether unprovided for in the artificial and valueless system of those authors." The Gnathobdellidæ are to be distinguished from

the Rhyncobdellidæ by the disappearance of all traces of a lateral sinus and of the dilatations connected therewith, as well as by the loss of all traces of the dorsal and ventral vessels; the lateral vessels and their connection with the dorsal and ventral sinus-system communicate only by a newly developed botryoidal tissue, which may play an important rôle, by forming a secondary cœlom. The communication between the existing cœlom and the true vascular system occurs either by vessels terminating with an open mouth, which is apparently provided with a sphincter in certain portions of the cœlom (e. g. the lateral dilatations and the branchiæ); or vessels may acquire a connection with new spaces forming in the connective tissue, which communicate on the other hand with small cœlomic remnants. The former method is characteristic of the Rhynco-, the latter of the Gnathobdellidæ.

After discussing in detail the characters of the nephridia of different genera, Mr. Bourne states his general conclusions with regard to them; he finds that they "present a serial arrangement with regard to their metameric repetition." The simplest condition is seen in *Clepsine*, where the nephridium in all cases opens into the cœlom on the one hand and to the exterior on the other.

The author concludes with a discussion of the question whether the Hirudinea are Platyhelminths, or more closely related to the Chætopoda. An answer to such a question must be based on a knowledge of (1) the amount of variability in any particular system of organs within the group itself, (2) the adult conditions of the systems of organs in the group as compared with other groups, and (3) the ontogenetic history of individual genera.

The last is not here used; as to the first, we note similarity of structure in many points, but variability in the characters of the anterior sucker, in the number of annuli forming a somite, and in the amount of cœlom present. "The curious distribution in the amount" of variability points to the very archaic nature of the group; the genera now living seem to have had an ancestor which presented as high a development of each system of organs as is found in any single genus of living Hirudinea.

Mr. Bourne thinks that it is quite impossible to prove that the Leeches are more highly developed Triclada or degenerate Chætopods. "The genetic relations are indirect and not direct." They present a resemblance to the Platyhelminth (1) in the possession of median genital pores; (2) in the suckers, to a certain extent; (3) in the general arrangement of muscles; and (4) in the structure of the pharynx of the Rhyncobdellidæ. They differ from Chætopods in the absence of parapodia and setæ, though the latter are, it is to be noted, absent from *Polygordius* and *Branchiobdella*. They agree with some Chætopods in the presence of a clitellum and in the habit of forming cocoons. The metamerism of the two groups may have been acquired separately and be due to different causes.

No definite statement as to the affinities of the Leeches can be given until we know the developmental history of the cœlom in them and in the Platyhelminths; the balance of evidence is certainly in

favour of their having had a common ancestor with the Triclada, but whether the Leeches have advanced or the Triclads degenerated is a problem that has yet to be solved.

External Morphology of the Leech.*—C. O. Whitman, as all who have worked at the species of Hirudinea will allow, justly refers in strong terms to the superficial and slovenly manner in which the diagnoses of species have been drawn up. He points out that no one appears to have suspected the existence of segmental sense-organs in the leech, and much less their serial homology with eyes. In the present essay he attempts, further, to show that the rings and somites form the only proper basis of classification.

The segmental sense-organs are in the form of papillæ, of which there are twenty-six transverse rows—one for each somite; they are, also, so disposed as to form eight longitudinal rows—two median, four lateral, and two marginal; the first may be regarded as the metameric equivalents of the first pair of eyes. While the true eye consists of a cylindrical mass of cells, three or four times as long as wide, in which the central portion is made up of peculiar large glassy cells, with a vacuolar central space, probably filled with some kind of fluid, the sections of the segmental papillæ present all the same elements, with the exception of a pigment-cup. The originals of the papillæ may have represented sense-organs of a more or less indifferent character, of which a few at the anterior have become light-perceiving organs, while the rest have either remained indifferent, or become specialized in another direction. Suggestions are made as to the relations of these organs to the segmental sense-organs of the lateral line in fishes.

A comparative study of *Hirudo* and the genera allied thereto is next entered on, and a careful definition of the genus *Hirudo* is given. The investigation of the abbreviated somites shows that abbreviation is greatest at either end of the body; the first six somites have lost seventeen rings, the last four eleven; this abbreviation is not, however, an actual loss, it is only a sacrifice in the interest of the rings retained; at the anterior end there has been a higher development of the sense-organs, at the posterior a greater development of muscles. It is very interesting to note that it is the non-papillate rings that have been suppressed; the abbreviation is believed to be still going on, and not to be equally rapid in different genera.

The author gives a table indicating his views as to the relationship of the genera, and in a postscript refers to Mr. Bourne's recent work, in which, he points out, there is no discussion as to the nature of the segmental papillæ, and in which the number of somites is determined by that of the ganglia.

Action of a Secretion obtained from the Medicinal Leech on the Coagulation of the Blood.†—Prof. J. B. Haycraft describes a series of experiments on the action which a secretion, obtained by solution from the medicinal leech, has on the coagulation of the blood, as

* Proc. Amer. Acad. Sci., xx. (1884) pp. 76–87 (1 pl.).
† Proc. Roy. Soc., xxxvi. (1884) pp. 478–87.

the result of which he finds that the leech secretes from its mouth a fluid which destroys the blood ferment without producing any other observable change in the blood. This fluid injected into an animal produces but slight constitutional disturbance, and is eliminated by the kidneys. The action on the rabbit is the same as on the dog; on crustacean blood it is inert. It has no action on the curdling of milk. It slightly hastens the clotting of myosin, and hastens rigor mortis.

Organization of Echinorhynchi.*—A. Säfftigen recommends that *Echinorhynchi* be killed slowly by being placed in a 0·1 per cent. solution of osmic acid, when they die in an expanded condition. Osmic acid is also the best reagent for histological investigations generally, but chromic acid and borax carmine are the best for a study of the nervous system.

The subcuticula is described as being composed of a complex plexus of fibres, a granular ground substance being altogether absent. The muscular character of these fibres is one which their general arrangement would lead us to accept. The author thinks, with various preceding writers, that the lemnisci are direct continuations of the subcuticula of the neck.

The true muscular tissue serves as the material from which most of the organs are built up; when extended, it is seen to form a continuous layer interrupted only by small spaces, and, as a rule, containing a large number of nuclei; indeed the structure appears to be syncytial. This tissue presents many points of resemblance to that of Nematodes, for, as in them, it consists of a fibrillated differentiated contractile substance, of a medullary layer, which is formed of a plexiform protoplasm, in the spaces in which there is a muscular fluid, and which contains nuclei, and of a structureless refracting membrane, which corresponds to Schneider's sarcolemma.

After a full discussion of the muscular system, the nervous system is dealt with; the cells of the cerebral ganglia are said to be proportionately larger, and, with the exception of the ovarian and seminal elements, are almost the only cells in the body which have a distinct peripheral contour. The central portion of the ganglion is occupied by a plexiform protoplasm with numerous vacuoles and some nuclei; the peripheral ganglionic cells are ordinarily unipolar, and are often in connection with nerves. The anterior median nerves are one to three in number, there is a paired lateral anterior and a similar posterior nerve-trunk. The distribution of these nerves is described.

The account of the genital organs commences with a discussion of the so-called ligament, the muscular nature of which has been already recognized by Greef; it forms a closed cylinder with a simple wall, the histological structure of which is similar to that of the muscular layers of the body; the account of the genital organs is very full.

In a concluding note Säfftigen directs attention to a recent paper by Mégnin, with many of whose results he does not find himself in accord.

* Morphol. Jahrbuch, x. (1884) pp. 120–71 (4 pls.).

Entozoic Worms.* — Dr. v. Linstow's annual paper on this subject gives descriptions of forms already known, at any rate by name, as well as accounts of new species. Twenty-six species are, in all, discussed, of which nine are new. There are some interesting observations on the widely distributed *Gordius aquaticus*, in which the author makes some criticisms on the account given by Villot.

Nervous System of Trematodes.†—From the observations of E. Gaffron it appears that in *Distomum isostomum* the nervous system consists of six longitudinal trunks connected together by a complicated system of commissures; there are three limbs on either side, one ventral, one dorsal, and one lateral. They unite anteriorly to form a dorsal cerebral commissure, which lies above the anterior part of the œsophagus. From the two lateral enlargements four nerve cords are given off, two anteriorly and two posteriorly. The ventral and dorsal longitudinal trunks undoubtedly correspond to the lateral nerves of *D. hepaticum;* at the hinder end of the animal they converge and pass into one another, while the lateral nerves remain separate. Six transverse bridges lying one behind the other, unite the ventral, dorsal and lateral trunks, and give rise to a wide-meshed nervous plexus in which are placed the viscera and generative organs. The ventral sucker is innervated by strong branches given off from the dorsal and ventral nerves. The minute structure of the nervous system offers no deviation from that already described by Lang.

Rhabdocœla from the Depths of the Lake of Geneva.‡ — G. Duplessis-Gouret, who attaches very great importance to the animals discovered at great depths either in sea or fresh water, gives an account of the Rhabdocœla of the Lake of Geneva; of these about a dozen species were found, of which one-fourth are new (? first found in the Lake of Geneva). There is evidence of their affinity to very ancient forms, and proofs that they are the remnants of a marine fauna.

The first worm mentioned is *Macrostoma hystrix* of Œrsted; the second *Microstoma lineare* Œrst.; this is remarkable for the complete absence of rhabdites from its integument, and for their replacement by what the author calls trichocysts; these are not, however, comparable to the organs so named by Allman in *Paramœcium*, but to the nematocysts, as they are ordinarily called, of *Hydra;* the author thinks that this discovery is of special importance in relation to the views of Lang as to the affinities of the Turbellaria and Ctenophora. Ciliated pits on the side of the head remind us of the similarly named parts in the Nemertinea. There is no anus, which is usually stated to be present in this genus; the intestine is provided with muscular walls and executes peristaltic movements—a phenomenon unknown in any other Rhabdocœle. The sexual organs are of the simplest character, and the sexes are distinct. The ovary

* Arch. f. Naturgesch., l. (1884) pp. 125–45 (3 pls.).

† Schneider's Zool. Beiträge, 1884, pp. 109–14 (1 pl.). Cf. Biol. Centralbl., iv. (1884) pp. 425–6.

‡ Arch. Zool. Expér. et. Gén., ii. (1884) pp. 37–68 (1 pl.).

is simple, unpaired, and devoid of any uterus or copulatory pouch. The testicular products do not seem to be formed by any special gland, but are merely developed in the peri-enteric portion of the mesoderm.

The third species, *Prorhynchus stagnalis*, has no eyes, and its skin has no rhabdites, but, in their places, there are a number of unicellular glands; the ciliated pits are less deep than in *Microstomum*. The next species described is the *Gyrator hermaphroditus* of Ehrenberg, *G. cæcus* of Graff.

Otomesostoma morgiense is most interesting on account of its frontal auditory vesicle, which is in direct relation to the bilobate cerebral ganglion; it is perfectly round, and its spherical otolith is suspended in a clear and homogeneous liquid; it is always completely at rest. On either side of the vesicle there are triangular pigment-spots, and it is possible that the organ has, at one and the same time, the function of an auditory and optic apparatus.

Mesostoma productum, *M. lingua*, *M. rostratum*, and *M. trunculum* are next described. *Typhloplana viridata* is the only species in the lake which is known to be of a green colour. This is due to the presence of unicellular parasites, which have a symbiotic relation to the worm.

Vortex intermedius is a new species, the testes of which are paired and compact, and open into a large bilobate seminal vesicle. The newness of the species is a matter of doubt; it may be only a variety of *V. truncatus*.

Plagiostoma lemani (= *Planaria lemani* Graff) is regarded as being the most important discovery among the deep-sea invertebrates of the lake. The intestinal tube has no muscular layer or special tunic of connective tissue, but rests directly on the mesoderm. There is, in fact, between the intestine and the skin nothing but a vast space which is filled up by a reticulated connective tissue with distinct nuclei where the fibres cross one another. The digestive sac is lobulated, the proboscis is protrusible, and the sexual organs follicular in character; by all these points this species shows itself to be intermediate between the Rhabdocœla and the Dendrocœla.

The author concludes by stating that this list of species is not to be regarded as being a complete catalogue of the Rhabdocœla of the lake.

Physiology of a Green Planarian.*— A. Barthélemy gives an account of his observations on *Convoluta schultzii*, in which especial attention is given to the chlorophyll-corpuscles, the physiology of which has already been investigated by Geddes. The author is inclined to look upon their presence as an example of the symbiosis of a unicellular alga and an acœlate worm, and he objects to the experiments of Geddes on the ground that they were carried on on a very large superficial area of Planarians. He finds himself that the bubbles of gas arise from fragments of sand or debris, and not from the animal; and, he asks, how could it be otherwise, when there is a continual

* Comptes Rendus, xcix. (1884) pp. 197–200.

movement of the vibratile cilia, which would oppose the formation of gas bubbles, and in the absence of any internal cavity in which the gas could accumulate or circulate?

"In reality, no vegetable or animal which is completely aquatic ever gives off gas under normal and regular conditions, and *Convoluta* offers no exception to this rule. In the presence of an excess of carbonic acid aquatic plants only give off oxygen when they present air passages where the leaves are detached from the stem, or when there is a layer of air on their surface." When there is an abnormal quantity of carbonic acid *Convoluta* deposits in its mesoderm very small grains of amyloid matter; it is killed when the excess of carbonic acid is too great. *C. schultzii*, then, absorbs through its cuticle carbonic acid in dissolution, which the chlorophyll decomposes in producing oxygen. This is wholly or partly utilized by the animal, in such a way that, if oxygen is expired, it can only be in very small quantities, and, under normal conditions, not in the gaseous state; the mode of respiration has a striking analogy to that of submerged aquatic plants.

Echinodermata.

Structure of Echinoderms.*—C. F. Jickeli has a preliminary note in which he states that he has made experiments confirmatory of the doctrine of Carpenter as to the nervous system of *Comatula*. He finds that a single arm gives no response when the ambulacral groove is touched with a needle or stimulated by an electric current, but that the moment the needle touches the point at which the axial cord lies the arm is strongly flexed, and the pinnulæ move actively. A single cirrus when stimulated appears to be thrown into a tetanic condition. Many of the author's experiments are in exact agreement with those of Carpenter. After the removal of the visceral mass irritation of the capsule produces a synchronous contraction of all the arms. If a few drops of osmic or acetic acid are put in the water the "torso" moves as actively as an uninjured animal.

The author describes the structure of the cirri, and the processes which pass from the "spongy organ" into them. The observations of P. H. Carpenter that nerve-branches pass into the dorsal and the ventral muscles is confirmed. A series of sections shows that the ambulacral nerve diminishes in extent as it approaches the intestine, and finally disappears. Attention is drawn to the fact that Götte describes the epithelium of the so-called ambulacral groove of *Comatula* as being endodermal in origin.

A third nerve-centre is described as being present in the connective tissue, and as forming a pentagonal cord around the mouth. The lateral cords are connected by branches with one another at the angles of the pentagon, and they extend along the water-vascular system. Each of these cords gives off lateral branches at regular distances, and these innervate the water-vascular system and the papillæ of the tentacles. Other well-developed branches are also

* Zool. Anzeig., vii. (1884) pp. 346–9, 366–70.

given off to the ventral integument of the body, where they are lost in a fine nervous plexus. Ludwig's view of the glandular character of the tentacles appears to be incorrect. They have 3–4 sensory hairs and a centrally-placed slowly-moving flagellum. From these observations it would follow that the tentacular papillæ are complicated sensory organs

Nervous System of Antedon rosaceus.*—This paper of Prof. A. Milnes Marshall is of especial interest after the recent communications† of Dr. Carpenter and Dr. Herbert Carpenter. After a short account of the general anatomy of *Antedon*, and an historical sketch of what has been done with regard to its anatomy and physiology, the author passes to an account of his own experimental investigations. The normal position of *A. rosaceus* is fixed; when it swims about it does so by strongly flexing the proximal half, and then extending the whole arm, the distal half of which is thrown out somewhat like a whip-lash or the line of a fly-rod. Irritation of the oral pinnules, however slight, causes them to be firmly fixed over the disk; if an *Antedon* be detached and placed with its oral surface downwards it will right itself almost at once. If an arm be cut off it will retain its vitality for many hours, and at first exhibit strong movements of flexion.

The first series of experiments were made on the *Effects of Removal of the Visceral Mass.* A large and vigorous specimen after evisceration swam about the tank actively, and, after a period of rest, again began spontaneously to move about; this experiment is the same as one of Dr. Carpenter's and proves that the co-ordinating mechanism which regulates the complex swimming movements of the arm is entirely without the visceral mass. The destruction of the direct connection between the sub-epithelial bands of the several arms renders it doubtful whether these bands have any regulating influence. Another experiment showed that the nervous connection between the sensory influence of any one of the arms or pinnules and the muscular system is outside the visceral mass. A third experiment gave evidence that the co-ordinating centre of the complex muscular movements is situated in the calyx.

The Power of Regeneration of Eviscerated Specimens has been observed in a series of specimens, on which the author promises fuller details; it is already clear that the power of regeneration in *Antedon* exceeds even that which is well known to be possessed by Holothurians.

The Functions of the Central Capsule were seen by experiment to be such that irritation causes strong flexion of the arms, and there is clearly a direct physiological connection between the capsule, and the muscles of the arm; and it is further clear that the sub-epithelial bands form no part of the central mechanism. Removal of the central capsule destroys the co-ordinating mechanism between the arms.

The Axial Cords were found to be the means of communication between the distal end of the arm and the motor mechanism; in other

* Quart. Journ. Micr. Sci., xxiv. (1884) pp. 507-48 (1 pl.).
† See this Journal, *ante*, p. 501.

words, the axial cord conveys impulses centripetally; and it appears also to be the sole means of afferent communication. As to their motor functions the results are similar, division of the axial cord destroying motor communications. The two arms of each pair are connected with each other by a transverse commissure.

The Sub-epithelial Bands appear to be nerves, and have probably a special and subordinate function in connection with the ambulacral tentacles and epithelium.

The author concludes with some observations on the morphology of the nervous system of Crinoids. He considers that the sub-epithelial bands are homologous with the radial nerve-band of an Asterid, and he looks upon the antambulacral nervous system (i. e. the central capsule, and axial cords with their branches) as being derived from the antambulacral part of the primitive nerve-sheath which invested the body, and not as an entirely new set of structures. The external and internal plexuses of *Echinus*, with their connecting fibres in the substance of the calcareous test, offer us an arrangement not altogether unlike that of the Crinoid. The difference, it must be remembered, between Crinoids and the rest of the Echinoderms is very great; not only is the Crinoid condition primitive, it is also highly specialized.

Nervous System of Crinoidea.*—Dr. W. B. Carpenter recapitulates the history of his inquiry into the nervous system of Crinoids, and indicates the points in which the histology and anatomical distribution of the fibres, which he has thought to be nervous, support his view. The theoretical homology of the relations between Crinoid and other Echinoderms is opposed by such facts as:

1. The absence of any branches from the sub-ambulacral nerves to the muscular apparatus of the Crinoidea generally.

2. The absence of sub-ambulacral nerves from those pinnules of *Antedon* which are most distinguished by their sensory endowments.

3. The absence of the same nerves from a large proportion of the arms of *Actinometra*, which, nevertheless, take their full share in the co-ordinated swimming movements of these animals.

4. The continued performance of these movements by *Antedons* from which the whole visceral mass, including the oral ring, has been removed, and by arms whose sub-ambulacral nerves have been cut near their base.

A point of great interest is the existence of a definite nervous system with very little histological differentiation; there is no definite distinction between ganglionic centres and nerve-trunks; almost every part of the apparatus is, probably, capable of originating as well as of conducting. That the axial cords are not mere conductors seems to be proved by the performance of active spontaneous movements by arms detached several days before from the body.

Dr. Carpenter refers to the views of his son and of Prof. Perrier who have supported his views from the anatomical side, and to the physiological experiments of Prof. Marshall and Dr. Jickeli.

* Proc. Roy. Soc., xxxvii. (1884) pp. 67–76.

Asteroidea of the Norwegian North Sea Expedition.*—D. C. Danielssen and J. Koren here give in a handsome and connected form, the results of their studies on the starfishes collected by the Norwegian North Sea Expedition, which have been separately published from time to time. The work is illustrated by fifteen plates as beautiful as those in preceding essays by the same naturalists. Reference is made to the difficulties of diagnosing the species, owing to the paucity of material, or the rarity of specimens for comparison, or the scattered condition of papers on the group, and their general lack of illustrations. The collection contained 41 species belonging to 20 genera; of these 11 species and 4 genera are new.

In face of the views held by various naturalists as to the significance of Prof. Perrier's discovery of *Caulaster pedunculatus*, it is interesting to note that Danielssen and Koren think that Perrier is correct in supposing that his new form is a connecting link between the Crinoidea and Asteroidea; their observations on their genus *Ilyaster* confirm the supposition. In the developmental stages of the Echinodermata the Crinoid represents the oldest and the Asteroid the youngest stages in the process.

Mimaster, a New Asterid.†—W. Percy Sladen describes a new and magnificent starfish, *Mimaster tizardi*, which is remarkable for presenting indications of affinity to several groups of starfishes. The arrangement and appearance of the paxillæ recalls *Solaster;* but the skeleton, in place of having its abactinal portion consisting of a closely reticulated calcareous framework, in which the paxillæ are borne, has it formed of paxillæ alone, the bases of which are closely placed, and occasionally overlap; this is the structure which has hitherto been supposed to be distinctive of the Astropectinidæ. *Mimaster* resembles the Goniasteridæ in the adambulacral plates, the ambulacral spines, and the mouth plates; the ventral plates recall those of the *Asterinidæ*, and have some likeness to the arrangement in the *Goniasteridæ*. The genus appears to be most closely allied to *Radiaster*, lately described by Perrier; but there are striking and important points of difference between them. The present form was collected by the 'Knight Errant' in the Faeroe Channel at a depth of 555 fathoms.

Amphicyclus, a New Holothurian.‡—Prof. F. Jeffrey Bell gives an account of a new genus of dendrochirotous Holothurians, for which he proposes the name of *Amphicyclus japonicus;* it is remarkable for having the ambulacral suckers arranged in regular rows (stichopod), together with the tentacles in two circles, fourteen in the outer, and ten in the inner; it seems to be most closely allied to *Actinocucumis*, with a stichopod arrangement of suckers and from 18–20 tentacles.

The author proposes to rearrange the Dendrochirotæ, by first taking note of whether the arrangement of suckers is regular

* 'Den Norske Nordhavs-Expedition 1876–8. XI. Asteroidea.' fol., 1884, 118 pp. (15 pls.). (In Norwegian and English.)

† Trans. Roy. Soc. Edin., xxx. (for 1881–2) pp. 579–84 (1 pl.).

‡ Proc. Zool. Soc. Lond., 1884, pp. 253–8.

(stichopod) or scattered over the surface of the body (sporadipod); some of the stichopod forms are armed with a rich supply of calcareous plates in their integument, and these are distinguished from the unarmed forms. Having thus arranged the genera in three groups, he takes as his second point of distinction the character of the tentacles; of which there may be ten radial and subequal, or ten radial, of which one pair is smaller than the other four; or more than five pairs. A phylogenetic table is given showing the affinities of the genera in relation to these co-ordinates.

Cuvierian Organs of the Cotton-Spinner.*—Prof. F. Jeffrey Bell gives a technical account of this almost unknown British Holothurian, which is of interest as being the only true—that is aspidochirotous (or with shield-shaped tentacles)—member of the class which is known to occur in the British seas.† The organ of most importance is that which produces the sticky secretion from which these animals have obtained their name, and which makes them objects of much dread to the Cornish fishermen. The producing or Cuvierian organs are described as forming a solid mass which occupies a large portion of the body-cavity, and which is made up of a number of separate tubes; a small coiled portion was found lying in the cloaca as if ready for ejection. A small piece of a tube measuring only 2·5 mm. was found, even after twenty years' immersion in spirit, to be capable of extension to twelve times its own length; while, when treated with water, the attenuated thread swells up to seven times its own breadth. "We can thus understand that an animal at whom these threads are thrown should, as it attempts to escape, lengthen the threads which, at the same time, coming into contact with the water, would be swollen out transversely as they were extended longitudinally." Prof. Bell thinks that the observations confirm the view of Semper as to the protective or offensive character of these organs, which by Jäger and most later anatomists have been thought to be renal in function.

In a subsequent note ‡ Prof. Bell states that six threads, any one of which was only barely visible, were capable of supporting a weight of nearly a thousand grains; and § quotes a letter from a correspondent to say that the black Holothurians near Porto Fino emit a tangled mass of white threads so sticky and in such quantity, that it was difficult to free the hands from them.

Porifera.

Vosmaer's Sponges.—The sixth part of this work ‖ (pp. 145–76 with plates XV.–XVIII.) has been published. The skeletal system is here entered upon, and, after an account of various systems of

* Proc. Zool. Soc. Lond., 1884, pp. 372–6.
† *H. intestinalis* of Norway has been found in the Minch.
‡ Nature, xxx. (1884) pp. 146–7.
§ Op. cit., p. 194.
‖ See this Journal, *ante*, p. 397.

classification, the characters of the spicules are described. Useful tables give the synonyms of the very various names applied to these bodies, and the author describes his system of formulation or rather stenography.

Protozoa.

Nuclei of Infusoria.*—In several Infusoria Dr. C. F. Jickeli has observed the extrusion of "polar bodies," a process entirely similar to that known to occur in the ovum; as in the case of the ovum these bodies are extruded from the greatly enlarged nucleus. In *Stylonychia mytilus* and other forms, the same observer has noted a multinuclear condition produced by the division into a number of irregularly sized fragments of the original nucleus; this may occur previously to any conjugation; it was found possible to produce the same effect by artificial means; examples of *Paramœcium caudatum* kept for eight days in the dark always showed this phenomenon, but the nucleolus remained unaltered. On the other hand a condition occasionally supervenes where the nucleus has entirely disappeared. During division the so-called nucleolus assumes the spindle form, but the nucleus does not; neither of these bodies however initiate cell-division which is always recognizable in the first place by the changes in the cell-protoplasm itself. The conjugation of Infusoria is a subject which has engaged the attention of many naturalists and their results are very conflicting; it appears that in some exceptional cases three individuals may fuse together, though more generally two; when this has taken place the Infusorian remains motionless for a time; the changes which follow commence in the cell-protoplasm and only subsequently extend to the nucleus; in those forms which possess a nucleolus the latter becomes widely separated from the nucleus at the commencement of conjugation or even before, but is connected with it by a fine thread; the nucleolus divides into a number of bodies, and in *Paramœcium* at any rate it is quite clear that there is an exchange between these two individuals of their nucleolar bodies; no such exchange was observable in the case of the nucleus.

New Infusorian—Ctedoctema acanthocrypta.†—Dr. A. C. Stokes has found on *Lemna* an Infusorian to which he gives the above name and the following diagnosis:—

Ctedoctema, gen. nov. (Greek, *ktedon*, a comb; *ktema*, a possession). Animalcules free-swimming, more or less ovate, persistent in shape, entirely ciliate; oral cilia diverse to those of the cuticular surface; oral aperture ventral, located at the posterior termination of a longitudinal, ciliated, adoral depression or groove which bears on its right-hand border a row of large acutely curved setose cilia, gradually diminishing in length towards the oral aperture which they surround, and with their distal extremities conspicuously thickened; several long setose hairs projecting from the posterior extremity of the body,

* Zool. Anzeig., vii. (1884) pp. 491–7.

† Amer. Natural., xviii. (1884) pp. 659–66 (4 figs.).

usually a single one being distally curved; contractile vesicle single, posteriorly placed; trichocysts large and numerous.

C. acanthocrypta, sp. nov. (Greek, *akantha*, spine; *kruptos*, concealed). Body elongate ovate, widest and rounded posteriorly, tapering to an obtuse anterior apex, subcylindrical, slightly compressed, the length twice to two and one-half times the breadth, a hemispherical sarcode bubble usually present on the left-hand dorso-lateral border; cuticular cilia long, fine, setose, a single postero-terminal seta usually distally curved; oral aperture ciliated, remote from the anterior apex, placed at the posterior termination of a shallow, narrowly ovate, ciliated, adoral groove centrally and longitudinally traversing three-fourths of the ventral surface, and bearing on its right-hand margin a flexible comb-like appendage composed of large, coarse, non-vibratile cilia, thickened distally and diminishing in length as they approach the oral aperture, which they surround, the adoral groove also bearing near its left-hand margin a row of long, fine, vibratile hairs, and throughout its entire length a series of long vibratile cilia, somewhat fascicled anteriorly, and shortening as they approach the mouth; contractile vesicle single, subterminally located near the right border; nucleus ovate, mesially placed in the anterior body-half; trichocysts large, straight, apparently prismatic, tapering to an obtuse point, and bearing distally two or more minute, radiating, linear processes. Length of body 1/1000 in.

The author thus deals with the question of reproduction:—"That reproduction is by transverse fission goes without saying. But if only that, imagine, if you can, what becomes of all the complex ciliary arrangement about the oral region. The creature to be fashioned from the posterior half of the mature body must have not only a ciliated adoral sinus, and the comb-like appendage, all of which simple division crosswise would give, but it must somehow obtain that ciliary fascicle at the anterior apex of that sinus. The posterior termination of the old *Ctedoctema's* groove has no such tuft to give the new creature, and the latter cannot, at least does not, exude sarcode filaments that shall stiffen into cilia. Then, when and how? Oh, it is so simple and so easy when it is once thought of! But no one ever would think of it without seeing it.

It is in this way. The cilia of that comb deliberately unite laterally and form a membrane. The anterior cilia of the sinus unite with it and lengthen the membrane to the front, the newly-formed tissue being widest somewhat in advance of its centre, and narrowing toward both ends. The animal then separates across the middle, forming two Holotrichous creatures, each with a perfectly smooth, unwrinkled membrane vibrating somewhat obliquely along the centre of its ventral surface, the free edge of this tip-tilting tissue being distinctly and strongly thickened. What scheme of classification has a place for them now? If they and the systematist should have a temporary encounter, what would he do with them? Would each be a fresh-water *Lembus*? Such questions give them no trouble. They at once proceed to form their ciliary appendages by splitting up their membrane to suit. The fringes unite to form the membrane,

the membrane divides to form the fringes, the thick edge then going into the thickened extremities of the adoral comb. In two hours, more or less, the sweet-water *Lembus* is a sweet-water *Ctedoctema*."

New Fresh-water Infusoria.*—Dr. A. C. Stokes also describes and figures some new genera and species of fresh-water Infusoria.

Loxodes vorax n. sp. resembles *L. rostratum* Ehr. superficially, but their anatomical differences are more conspicuous than their likeness. Its favourite diet is diatoms and small rhizopods.

Apgaria nov. gen. is probably near *Blepharisma* in systematic position. There are three species, *A. undulans*, *A. ovata*, and *A. elongata*. *Ileonema* nov. gen. *I. dispar* nov. sp. closely resembles in contour *Tracheophyllum apiculatum* C. & L. If from the latter the acutely conical anterior apex is removed and the flagellum of *Ileonema* be added, "the result would be a species of the genus now under notice, the likeness between the contrasted forms being also striking." The author thinks it may be considered a link intimately connecting the two orders of the Flagellata-Eustomata and the Cilio-Flagellata.

Solenotus nov. gen. approaches nearest to Stein's *Colponema*, but cannot be admitted into that genus by the absence of the anterior curvature, by the apical origin of the trailing flagellum, and by the presence of a dorsal instead of a ventral groove. Two species, *S. apocamptus* and *S. orbicularis*, are described.

Life-history of Stentor cæruleus.†—Prof. G. W. Worcester gives a detailed description of the development and life-history of *Stentor cæruleus*, which can hardly be satisfactorily abstracted. When first observed it appeared a motionless, intensely blue mass, containing what seemed to be a row of internal vacuoles, which later proved to be the moniliform endoplast of the mature infusorian. A larger vacuole was observed that subsequently became the mouth. The mass slowly changed its form, developing cilia at each extremity. The cilia eventually disappeared from one end, the shape was constantly varied, and in a little less than two hours it had put on the mature form and was swimming very rapidly. Conjugation with another specimen was then observed, each fastening itself by its posterior end to some object, their backs meeting, when they would roll over each other till their anterior extremities met. Conjugation lasted some moments when the specimens separated and swam away. The individual observed lost its bluish tint and became of a bronze colour. About an hour and a half after the conjugation it stopped suddenly, assumed a flat spread-out condition, whilst at the same time large vacuoles appeared throughout its entire mass. In appearance it was *amœba*-like and after a time small masses became detached and immediately assumed a globular form. The detachment of masses whilst in this *amœba*-like stage in other specimens was witnessed, as also their development into mature forms.

The main mass would in some instances disintegrate after portions

* Amer. Journ. Sci., xxviii. (1884) pp. 38–49 (10 figs.).
† Proc. Central Ohio Sci. Assoc., i. (1884) pp. 97–106 (4 pls.).

had been detached to form new individuals, nearly all the granular mass flowing out and leaving a row of egg-like bodies, the exact nature of which the author was unable to determine; he considers, however, that in them begins the cycle of life.

In one instance the specimen under observation only partially disintegrated, "the ciliated part and a little more" remaining intact and subsequently reforming into a perfect individual. Reproduction by the formation of internal embryos was also observed, likewise the rarer method by fission proper.

Prof. Worcester considers the primitive form to be that of a sphere and that the series of later forms assumed are so taken on by the creature in order to adapt itself more fully to its environment. The posterior end would seem to be appended more for locomotion and for the purpose of fixing itself. Conjugation must in some way play an important part in the rearranging of the protoplasm.

New Protozoa.*—O. Nüsslin describes four new Protozoa from a lake in the Black Forest. The first is a new genus of Rhizopoda, to which he gives the name of *Zonomyxa violacea;* it is defined as a large fresh-water Rhizopod, nearly spherical in form when at rest, and completely inclosed in a delicate chitinous investment, and as giving off, by a number of small violet vacuoles, a violet coloured protoplasm; it may or may not have nuclei, which vary in size and number. Large individuals have a diameter of from ·15 to ·2 mm. The chitinous investment has great contractile power, and is remarkable for its power of resisting the action of acids and alkalies, even when highly concentrated. The contained protoplasm is vacuolar or reticular, but has a homogeneous thickened periphery. Small violet vacuoles are scattered through the whole of the interior, but especially form a subperipheral zone; the colouring matter is extraordinarily sensitive to the influence of very dilute acids or alkalies. In addition to these coloured there are also colourless vacuoles, which cannot be strictly said to be contractile. Highly refractive bodies, resembling the "Glanzkörper" described by Greef in *Pelomyxa*, were also observed. A completely developed nucleus does not seem to appear until about the period of encystation, and thence a number are to be seen; the substance of which they are composed seems to be excessively soft, and their contents are made extraordinarily pale and almost homogeneous by the addition of 10 per cent. solution of acetic acid. It is particularly noted that some time after encystation, when the true nuclei have disappeared, and the protoplasm has lost its colour and vacuoles, large homogeneous protoplasmic masses appear; these, however, are not, as a rule, acted on by carmine, and do not appear to be of a nuclear nature. The movements of the body are of very various kinds; sometimes they creep like a flatworm or a leech; the varieties of branching seem to be beyond description.

After describing the process of encystation the author passes to a discussion of the systematic position of his new genus, and allocates

* Zeitschr. f. Wiss. Zool., xl. (1884) pp. 697–724 (2 pls.).

it between the two genera *Amphizonella* and *Pelomyxa* described by Greef; with the former it agrees in the mode of formation of its investment and of its pseudopodia, and in its violet colour; with the latter in the vacuolated character of its protoplasm, the possession of refractive bodies, and in the peculiarities of its nucleus.

The new species of Vorticellid next described is a species of *Vaginicola*—*V. bütschlii*—which is found attached to plants; the body has green granules, is rounded posteriorly, and has no stalk-like organ of attachment; the shell is more or less depressed, and has a lateral keel at its hinder end. The shell, which varies greatly in form, is in all cases to be recognized by its wide orifice; it is bright brown in colour.

Another new Vorticellid is *Epistylis ophrydiiformis*, which is extraordinarily elongated, is attached to low and very thin branched stalks, but is not rarely found separated. It is especially interesting from the possession of an organ which is connected, on the one hand, with the vestibule, and, on the other, with the contractile vacuole; this has the function of allowing the vacuole to empty itself into the vestibule. It may be called the reservoir-apparatus, as it is clearly a highly differentiated stage of the organ already seen in *Carchesium polypinum* (Greef), and three species of *Vorticella* (Bütschli). The reservoir is a rounded vesicle containing a spongy network of protoplasmic filaments, has a tubular neck-like appendage, and contains in its walls distinctly contractile bands, which appear to cross one another. The sack, which is connected with the contractile vacuole, expands on every systole of the vacuole. The bands on the surface of the sack must be regarded as contractile protoplasmic bands, which, on the principle of division of labour, have taken on the duties which, in other Protozoa, were performed by the protoplasm of the cell generally. On the whole, the reservoir may be regarded as a regulator of the movements of the contractile vacuole.

The last form described is *Amphitrema stenostoma* n. sp., in which the two orifices of the test are narrowed inwards in an infundibular fashion, but have no external circular ridge or any constrictions. The nucleus is large and vesicular. It appears to be most nearly allied to *A. wrightianum* of Archer, and the differences between the two forms are successively pointed out. Attention is directed to the fact that the pseudopodia are sometimes distinctly lobate, and sometimes as distinctly filamentar, and once pseudopodia of the two kinds were seen to be simultaneously extruded from either hole. The test seems to have the chemical character of the cell-membrane of the Desmidiaceæ. Foreign bodies, in the form of small stones and crystals, more rarely of diatom tests, are to be found closely packed, especially at one pole of the body.

'Challenger' Foraminifera.*—H. B. Brady's report treats fully of the classification of the Foraminifera, with a sketch of the gradual development of our knowledge from the time of D'Orbigny (1826) to

* Report of the Voyage of H.M.S. 'Challenger.' Zoology, ix. (1884) 800 pp. (115 pls.).

the present, and it has an elaborately compiled bibliography. The various classifications of the Rhizopods, from that of Dujardin in 1841 to that of Leidy in 1879, are glanced at. More details are given as to the various attempts at classifying the Foraminifera, and the author proposes a scheme differing in many respects, and often widely, from those given by previous writers, but one which, in its essential elements, is in no way incompatible with the different conclusions at which they had arrived. The nature of the investment of the animal —that is to say, the minute structure of its test—as an exclusive basis for the primary divisions of the order has been abandoned. While under all circumstances it furnishes important characters, and is even in some families quite distinctive, it is nevertheless a fact that, whilst there are certain groups which are invariably arenaceous, and some which are always calcareous and perforate, there are yet others in which no uniform rule obtains. The author omits any division of the order into sub-orders, not finding any easily recognized characters to serve as a basis for such subdivision, and he divides the order at once into families. These families are (1) Gromidæ, (2) Miliolidæ, (3) Astrorhizidæ, (4) Lituolidæ, (5) Textularidæ, (6) Cheilostomidæ, (7) Lagenidæ, (8) Globigerinidæ, (9) Rotalidæ, (10) Nummulinidæ. The Gromidæ, a family composed chiefly of fresh-water organisms, "have been a source of considerable trouble, on account of the want of accuracy and detail in the published descriptions of a number of types more or less closely allied to the group, and only such genera have been included as are known to have long, reticulated pseudopodia."

One of the most interesting subjects in reference to deep-sea deposits is their direct connection with the pelagic species of Foraminifera. As a rule these forms are not of pelagic habit; on the contrary, probably 98 or 99 per cent. of the known species or varieties live in the sand or mud of the sea-bottom, and possess no powers of floating or swimming; but, on the other hand, some few forms, belonging to eight or nine genera, do most certainly pass their existence either in part or in whole at the surface of the ocean, or floating at some depth below that surface. These forms are found, too, in immense profusion, and a relatively very large mass of the oceanic deposits consist of their calcareous shells. A list of the at present ascertained pelagic forms is given. The most prominent genera are *Globigerina*, *Pulvinulina*, *Hastigerina*, and *Pullenia*. The question seems still unsettled as to whether the species are exclusively pelagic, passing the whole of their time living at or near the surface, or whether they can or do pass a certain portion of it on the sea-bottom. Mr. Brady adduces a series of facts which tend to the inference that the Foraminifera which are found living in the open ocean have also the power of supporting life on the surface of the bottom-ooze, and further, so far as our present knowledge goes, there is at least one variety of the genus *Globigerina* which lives only at the sea-bottom; but the author is most cautious not to express any dogmatic opinion on the subject.

In dealing with the composition of the test, the presence of a

considerable percentage (6 to 10) of silica has been established as existing in the arenaceous forms. The substance secreted for the incorporation of the foreign bodies which cover the test has been proved to be composed of ferric oxide and carbonate of lime in variable proportions, the former being often in considerable excess. It is not without interest to note the presence in some of the porcellanous forms of a thin siliceous investment. A few *Miliolæ* from soundings of a depth of about four and a half miles, with somewhat inflated segments, scarcely distinguishable in form from young thin-shelled specimens of a common littoral species, were found to be unaffected by treatment with acids, and upon further examination it became apparent that the normal calcareous shell had given place to a delicate homogeneous siliceous investment. While immersed in fluid, the shell-wall had the appearance of a nearly transparent film, and this when dried was at first somewhat iridescent.

A list is given of those stations from which soundings or dredgings were obtained in sufficient quantity to furnish good representative series of Rhizopods, and maps are appended showing the tracks of the 'Challenger,' with these stations marked, as also of the areas explored by the 'Porcupine' and other northern expeditions.

Any generalized summary of the details of the new forms would be impossible. Of the several hundred species described and figured, over eighty are here noted for the first time, and this without counting numerous well-marked and named varieties, or the numerous new forms already diagnosed in Mr. Brady's preliminary reports.

The family Astrorhizidæ is the one which has received the largest number of additions; indeed our acquaintance with the larger arenaceous Rhizopods is almost entirely derived from the various recent deep-sea explorations. A knowledge of the life-history of these forms is still needed to place the classification of the group on a secure basis, and as some few of the forms are inhabitants of comparatively shallow water, their investigation would seem to be well worthy of the attention of observers at some of our zoological marine stations. Many other problems to be solved are also pointed out in this report, the extreme value of which will be recognized by all students of biology.*

Copulation in Difflugia globulosa.†—But few observations have been recorded on the copulation and conjugation of Rhizopoda. An instance of this phenomenon has been studied by Dr. C. F. Jickeli who gives the following description of it. Two examples of *D. globulosa*, one distinguishable by the greater transparency of its shell, were observed to attach themselves together by the mouth aperture; from this point four long and mobile pseudopodia extended themselves; in 24 hours the animals were still firmly attached, but the pseudopodia had vanished; after the lapse of another 24 hours the shells had become detached. On investigating the two by means of reagents, it was found that the shell of the individual formerly recognizable by its

* Nature, xxx. (1884) pp. 533–4.
† Zool. Anzeig., vii. (1884) pp. 449–51.

greater transparency was entirely empty, while the protoplasm of the other contained two entire nuclei, and another partly broken up into fragments. This process appears to be undoubtedly a kind of copulation, though the actual coming together of the two individuals was not observed; it is evidently no case of division and the only possibility is that it might be equivalent to a rejuvenescence; this objection may, however, be refuted by the observation of the active pseudopodial processes and by the breaking up of one of the nuclei, and also by the fact that it was not the more transparent but the more granular individual which finally retained the whole protoplasm of the two; moreover in other individuals of the same species the most careful search failed to show more than one or two nuclei. It appears therefore that (1) copulation takes place among Rhizopoda as well as among Infusoria; (2) during the process there is a stage of diminished vital activity in both groups; (3) as a result of the process there is a breaking up of the nuclei.

Development of Stylorhynchus longicollis.*—The results of A. Schneider's researches on the development of this Gregarine, may be thus summed up:

Stylorhynchus longicollis passes through most of the stages of its development, and often even acquires the characters of the adult, in the interior of an epithelial cell of the intestinal tract of *Blaps*. This fact shows that Giard is not justified in drawing a distinction between Gregarines as forms living in cavities where they are free and Psorosperms as being intracellular parasites. One and the same epithelial cell may contain a varying number of inhabitants, which may either be separated from one another, or united in groups; in the latter case they are more or less deformed by the pressure they exert on one another. The parasites may be found between the nucleus and the nuclear membrane. At first they are identical with the forms known as Coccidia, and, in their development, four stages are to be distinguished; in the first they are simple cells with a solid nucleus, in the second the nucleus becomes vesicular, in the third they have the form of segmented cells with a nucleus in the proximal segment, and in the fourth they are segmented cells with a nucleus in the distal segment.

The segmentation of the body, which is at first purely external and superficial, precedes the migration of the nucleus from one to the other pole. The septa in the cell do not appear until after the migration of the nucleus. The cavity in the rostrum corresponds to the position occupied by the nucleus before its migration. The segment first produced is the fixation-apparatus of the adult; the next to appear is the deutomerite or distal segment, then the protomerite, and then the neck.

Strictly speaking, the first segment buds off the rest, and the phenomenon of spontaneous mutilation is, morphologically, comparable to the act by which a bud is separated from the mother-cell. In *S. longicollis* development is direct, for there is no alternate generation, or

* Arch. Zool. Expér. et Gén., ii. (1884) pp. 1–36 (1 pl.).

any change of host. The second parasite *Chytridiopsis socius*, which is sometimes found in the epithelial cell with *Stylorhynchus*, has nothing to do with the developmental history of the Gregarine.

Flagellated Organisms in Blood of Animals.*—T. R. Lewis describes certain flagellated organisms which he first detected in the blood of two species of *Mus*, and which have since been seen in other animals; the characters of these are given in detail. Notwithstanding many attempts a flagellum could be demonstrated at one end only. The author is wholly unable to explain the presence of these flagellated organisms in blood; for some time he was inclined to think that they were the spermatozoa of some parasite hidden in the tissues of the animal, but further observation showed that the contents of the segments of a tapeworm were much more sensitive than they to the action of water. Saville-Kent has named them *Herpetomonas lewisi*, but points out that further research "may possibly demonstrate their identity with the discharged spermatic elements of the minute nematodes, micro-filariæ, or other metazoic endoparasitic forms known to flourish amid the same surroundings."

Parasitic Proteromonadidæ.†—By way of a first contribution to a monograph of the parasitic "Infusoria," J. Künstler describes two new forms belonging to the Proteromonadidæ, which ranks as the lowest family in the Monads, and may be considered as occupying to a certain extent an intermediate position between some of the Schizomycetes and the Monads.

Two species constitute the family:—*Proteromonas Regnardi* inhabits the intestine of *Cistudo europæa* Schneid.; in which it swarms, often forming a considerable mass of intertwined individuals in the digestive tube. It is divisible into flagellum and body. The flagellum, often more than twice the length of the body, is single and placed at the anterior extremity of the body, with which it appears to be continuous, owing to its remarkable size at the base. In its minute structure the flagellum presents no exceptional characteristics, and the author found in it the same alternation of dense and aqueous portions that he previously described in other forms.‡ The body is about ·022 mm. in length and divisible into two portions. The posterior portion constitutes a sort of tail, and plays the part of a locomotor organ whose power is frequently increased by the existence of a caudal filament of extreme tenuity and often invisible. The anterior portion is more complex and colours intensely under certain reagents, such as hæmatoxylin. The examination of the surface ordinarily presents bosses and folds as if a loose membranous envelope were wrapped round an internal body.

The reproductive phenomena are very extraordinary. The anterior region of the body often exhibits swellings, most frequently situated on the dorsal face, but also often on the ventral. Some of

* Quart. Journ. Micr. Sci., xxiv. (1884) pp. 357–69.
† Ann. Sci. Nat. Bordeaux, ii. (1883) pp. 45–54 (2 pls.).
‡ Bull. Soc. Zool. France, vii. (1882) pp. 1–112.

these after attaining certain dimensions contract more or less at the point of attachment to the body so as to be sharply distinguished from it by a circular furrow. They sometimes form an annular swelling. The author considers that he has established with "a certainty nearly complete" that they give rise to new individuals. Multiplication also takes place by a species of transverse fission.

The other species described is *Giardia agilis* Künst.*

BOTANY.

A. GENERAL, including Embryology and Histology of the Phanerogamia.

Observations on Vegetable and Animal Cells.†—In the first part—the only one yet published—J. M. Macfarlane deals with the vegetable cell, and especially with that of *Chara fragilis*. The author has already shown that a nucleolus and a nucleolo-nucleus, or (as he now, at Prof. Rutherford's suggestion calls it) an *endonucleolus*, are essential parts of every growing vegetable cell. In stages where there are several nuclei, Mr. Macfarlane found that staining in eosin, &c., with previous decolorizing of the preparations, enabled him to see the nuclei better than with the osmic acid process. No definite observations were made on the endonucleus of *Chara*, on account of its having been too deeply stained. In every active embryonic cell, only one nucleolus is present in the resting state, and the action of reagents and its thick and viscid nature indicate that it is a vesicle containing richly differentiated protoplasm. The nuclear spindle or barrel is regarded as being merely a scaffolding thrown across the space between the halves of the dividing nucleus, and so helping the protoplasm in its work of depositing the septum. No definite spindle is to be seen in *Chara*.

There appears to be evidence that in all plants the multinucleolar is succeeded by a multinuclear condition, and the author regards it as a general principle that, after cell-formation has ceased, the cell-contents (especially the endonucleus and nucleolus) persist in their activity for a shorter or longer period; and this activity depends on the condition of nutrition of the cell.

In summing up, Mr. Macfarlane says, "It will be seen that I regard the building-up of cells to form a definite plant or the parts of it, as the result of a force radiating from the cell-centre, stimulating to division; and either that the energy giving rise to this force is equal to producing only a certain amount of tissue, or that it is inhibited or resisted by some external force, which prevents it forming an excess of tissue, when this would tend to pathological change, or to loss of individuality in the plant. The most exalted type of cell is

* See this Journal, ii. (1882) p. 804.

† Trans. Roy. Soc. Edin., xxx. (for 1881–2) pp. 585–95 (1 pl.).

one with abundant protoplasm containing a single nucleus, nucleolus, and endonucleus; a cell with vacuolated protoplasm, one nucleus, and two to four nucleoli is less exalted; the multinuclear state is most degraded."

Structure and Division of the Nucleus.*—L. Guignard has re-investigated the phenomena connected with the division of the cell-nucleus in the mother-cell of the pollen-grains, and in the ovary; the plants examined being chiefly monocotyledons—*Lilium Martagon*, *Allium ursinum*, *Alstrœmeria pelegrina*, *Listera ovata*, and others. At the time of division the nucleus is invested with a delicate membrane which behaves to reagents in the same way as the microsomes of the cytoplasm surrounding the nucleus. It is coloured by carmine and hæmatoxylin, while safranin scarcely reveals it; with slightly acidulated methyl-green it presents a double contour and a much more pronounced staining than the cytoplasm.

The author agrees with Strasburger—contrary to the opinion of Flemming—that when the nucleus is at rest it contains a single continuous filament, which, with the nucleoli, contains all the chromatin of the nucleus. At the moment of division the nucleoli disappear, the filament contracts, and then divides into a certain number of rods; these rods curve on themselves, and the two parts thus defined become more and more closely attached to one another; they then arrange themselves in a plane and form the nuclear plate. Almost at the same moment the membrane of the nucleus disappears, and the achromatic filaments then make their appearance, arranging themselves in the form of a barrel. In the next stage the rods divide longitudinally, and each of the halves moves to one pole of the barrel formed by the achromatic filaments. The filaments at each pole then unite end to end, and form the nucleus of a daughter-cell, going through in inverse order the series of transformations which took place in the nucleus of the mother-cell. The origin of the achromatic filaments he regards as still obscure.

Guignard regards the nucleoli not simply as denser parts of the substance of the nucleus, but as a special product of its metamorphosis and of the vital activity of the nucleus. They are not invested by a membrane, and are readily distinguished by their optical properties and their receptivity to staining, from the chromatic substance of the nucleus. In *Listera ovata*, hæmatoxylin stains them entirely a yellow red, while the filament becomes dark violet.

Formation of Endosperm in Daphne.†—E. Strasburger contests the statement of Prohaska ‡ as to the formation of free nuclei in the embryo-sac of *Daphne Blagyana*. He asserts that the structures described by Prohaska as free nuclei are not found in the parietal protoplasmic layer.

* Ann. Sci. Nat. (Bot.) xvii. (1884) pp. 5–59 (4 pls.). Cf. this Journal, iii. (1883) p. 864.

† Ber. Deutsch. Bot. Gesell., ii. (1884) pp. 112–4.

‡ See this Journal, *ante*, p. 250.

Method of Bursting of Sporangia and Pollen-sacs.*—H. Schinz has investigated this subject. He regards the cause of the bursting to be peculiarly thickened "opening cells," which effect a bending of the wall of the anther or sporangium from their change of form on drying. This change of form is effected in two different ways:—(1) In *Encephalartos* by a strong thickening of the outer wall of all the peripheral cells, by means of a substance full of water, and the contraction of these parts in the tangential direction on drying; the anther-wall consists of three layers, the outermost layer causing the expulsion. (2) In all other structures, by a mode of thickening which causes a hinge-like motion of the actual cells; i. e. an approach of their outer margins next the epidermis on drying, resulting from the inner and side-walls of the cells being strongly thickened, the loss of water on drying affecting to the greatest extent the innermost layers which bound the cell-cavity. Of this latter mode there are three varieties, viz.:—(1) The sporangia of ferns; the wall consists of one layer; the opening-cells are converted into an annulus. (2) Gymnosperms, except Cycadeæ; the wall consists of one layer of scalariform opening-cells. (3) Cycadeæ, except *Encephalartos;* the wall consists of three layers; all the epidermal cells thickened after the manner of an annulus. (4) Angiosperms; the wall consists of three layers; the endothecium composed of cells thickened in the hinge-fashion, and alone taking part in the bursting.

Pollen from Funereal Garlands found in an Egyptian Tomb.†—C. F. White figures the pollen-grains and anther of *Papaver Rhœas* from the funereal garlands found in Egypt in the coffin of the Princess Nzi Khonson of the XXI. Dynasty about 1000 B.C., and compares them with drawings from recent gatherings of the plant. The former appear to be slightly the larger. Mr. White especially calls attention to the readiness with which these ancient specimens absorb water and expand into that subspherical shape so usual with pollen of simple form; with the peculiarity that the Egyptian assume the *three-lobed* shape common to many pollens, the furrows becoming deeper than when dry, instead of, as generally happens, being nearly obliterated when placed in water. No indication of the appearance of the pollen-tubes could be detected except that at one of the three points at which they would be produced, a small bubble of air was in several cases observed.

Swelling Properties of Vegetable Cell-membrane.‡—F. von Höhnel has tried a series of experiments on the capacity of swelling possessed by different vegetable fibres:—aloe, *Phormium tenax*, Manila hemp, flax, *Boehmeria tenacissima*, and hemp. He finds that, under long-continued swelling, fibres may first increase and then decrease in length. A dry membrane artificially compressed in the direction of its length acquires positive optical properties; it then increases in length under swelling in water and becomes again negative.

* Schinz, N., 'Unters. ü. d. Mechanismus d. Aufspringens d. Sporangien u. Pollensäcke' (3 pls.) Zürich, 1883. See Bot. Centralbl., xviii. (1884) p. 361.

† Journ. Linn. Soc. Lond. (Bot.) xxi. (1884) p. 251 (1 pl.).

‡ Ber. Deutsch. Bot. Gesell., ii. (1884) pp. 41–51.

Epidermal Tissue of the Root.*—O. Juel finds, in several water plants, in addition to the ordinary elongated cells of the epidermis of the germinating root, other nearly cubical cells, from which spring root-hairs. The hypodermal layer of cells of the root may have the side walls of the elongated cells either parallel or convex with respect to one another. The short cells vary in width, and may be narrower or broader than the elongated cells; and looked at from the surface their outline may be circular, elliptical, square, or rectangular. The walls of the two kinds of cells appear to be of about equal thickness.

Lenticels.†—H. Klebahn does not find the absolute distinction, previously ‡ insisted on, between the closing layer and the intermediate layer in lenticels. The whole tissue outside the renewing layer he includes under the term intermediate substance; and this may occur in two modifications:—(1) It consists only of cork-cells, which leave intercellular spaces between them, which Klebahn terms *pore-cork;* (2) it consists of alternate suberized and non-suberized layers, while he calls the separate unsuberized layers *choriphelloid.* The cells of this tissue proceed centripetally from the renewing layer, and the cell-walls are either lignified or consist of pure cellulose; their thickness varies. All lenticels belong to one or other of these types.

Klebahn finds lenticels on the aerial roots of *Philodendron pertusum,* resembling those of the Marattiaceæ, and consisting of dense layers without intercellular spaces, the loose intermediate cells being suberized. He also finds lenticels on the medullary rays in *Vitis* and *Clematis.*

The chief function of lenticels is undoubtedly to facilitate the entrance of gases through the otherwise almost impermeable outer layers of the cortex.

Torsion of Twining Stems.§—F. G. Kohl believes he has established the fact, stated by Mohl, but doubted by Darwin and de Vries, of the sensitiveness of a twining stem to permanent lateral contact. He does not agree with Schwendener in regarding antidromous torsion only as normal, homodromous torsion occurring normally with thin supports, and then changing to antidromous when the support exceeds a certain thickness, or when the friction between the climbing stem and the support is increased.

Structure and Growth of Palms.‖—Branner gives some interesting results of original and apparently careful studies of the mode of growth of many palms.

The essential points of difference between these results and those obtained by other observers relate to the development of the fronds.

* SB. Bot. Gesell. Stockholm, Feb. 27, 1884. See Bot. Centralbl., xviii. (1884) p. 282.

† Jenaisch. Zeitschr. f. Naturwiss., x. (1884). See Bot. Centralbl., xviii. (1884) p. 236.

‡ See this Journal, *ante,* p. 78.

§ Pringsheim's Jahrb. f. Wiss. Bot., xv. (1884) pp. 327–60 (1 pl.).

‖ Proc. Amer. Phil. Soc., 18th April, 1884. Amer. Journ. Sci., xxviii. (1884) pp. 239–40.

The fronds are developed in connection with the *central* bundles in the phyllophore. In regard to the origin of the bundles, it is sufficient at present to say that they originate at the apex of the phyllophore, and are developed in it, with it, and as a part of it. von Mohl and Mirbel maintain that these bundles grow up into the phyllophore; Gaudichaud, that they grow downward from it, from the frond bases; von Martius, that they grow both up and down; while the author maintains that they are perfected in all directions at the same time, though the lateral growth continues to a certain extent after the longitudinal growth has ceased, and that they can no more be said to grow upward or downward than it can be said of the bones of the body that they grow outwards into the limbs. It is true that the general lengthening of the bundles takes place at the superior end, but there is a growth besides this. At the first appearance of the fronds at the apex of the phyllophore, the fibro-vascular bundles are already connected with them, and just as intimately as they are in the perfectly developed frond. The internodes at this point are very short, but the bundles are the same in number, and have exactly the same connections, direction and relation to each other that they have in later life. But in the perfected frond we find them larger, longer, and harder, and in the perfect stem the internodes are longer, the stem and bundles larger, while the whole plant has grown both longitudinally and laterally.

Honey-glands of Cruciferæ.*—J. Velenovsky has examined the honey-glands in about 170 species of Cruciferæ, and finds them only of subordinate use in classification; they are generally related to the habit of the plant, and the structure and form of the fruit. As a general rule, though not without exception, their size is in proportion to that of the flower. While the lower glands are never absent, though sometimes very small and almost rudimentary, the upper glands are not unfrequently entirely wanting.

Resin-deposits.†—T. Posewitz has investigated the mode in which the enormous deposits of resin in Borneo are formed. It is produced chiefly by trees belonging to the Abietineæ, Burseraceæ, and Dipterocarpeæ, the resin falling from the branches in large lumps, which become mixed with mud and transported by heavy rains to the neighbourhood of the sea. The remains of animals are found abundantly inclosed, both of insects and of other larger animals, land or marine, picked up during their transport. The author compares this with the modes of formation of peat and of amber.

Distribution of Food-materials in the Plant.‡—Berthelot and André find that insoluble mineral substances accumulate in the leaves and inflorescence in preference to any other part of the plant, the leaves being the termination of the circulation of fluids; they amount

* SB. K. Böhm. Gesell. Wiss., vi. (1884) (5 pls.). See Bot. Centralbl., xix. (1884) p. 9. Cf. this Journal, iii. (1883) p. 239.

† Földtani Közlöny (Buda-Pest) xiii. (1883) pp. 409–12.

‡ Comptes Rendus, xcix. (1884) pp. 428–31.

to from 20 to 25 per cent. of the total weight of the leaves. The absolute amount of mineral substances in the stem is considerable, but the relative amount is small, not above about 4 per cent. at the time of the death of the plant. The roots contain very little mineral matter, except when the plant has been deprived of inflorescence; it gradually decreases during the life of the plant.

Transpiration of Plants in the Tropics.*—V. Marcano finds that, in the tropics, plants evaporate in the night (from 6 p.m. to 6 a.m.) a quantity of water which is distinctly equal to that which they evaporate during the day. During the day this evaporation takes place chiefly between 6 a.m. and noon. The maximum is remarkable for its constancy and extent, being half or even three-quarters of that which is evaporated during the twelve hours of the day; it generally takes place after 10.15 a.m., and almost always before noon. From the maximal point to 6 p.m. the evaporation is very feeble. The hygrometric condition of the air does not seem to have any great influence on transpiration.

Although nocturnal evaporation from leaves has been denied by the great majority of vegetable physiologists, the proofs now adduced find support in the views of Boussingault, who speaks of hearing water continually dropping from the neighbouring trees, when bivouacking at night in the open air, and explains it by suggesting that transpiration from the green parts of plants has some share in causing the phenomenon.

Chemical Phenomena of the Assimilation of Plants.†—Dr. T. L. Phipson details the experiments which lead him to consider that peroxide of hydrogen plays a great and hitherto unsuspected part in the process of assimilation.

Histo-Chemistry of Plants.‡—In an interesting contribution to the "histo-chemistry" of plants A. Rosoll illustrates the light that can be thrown upon vegetable principles by studying them microchemically *in situ* in the plant.

The first plant mentioned is *Helichrysum bracteatum*, the yellow flower-heads of which are well known as a variety of "everlasting flowers." This yellow colour is very persistent; but when the dried flower-heads are dipped into borax solution to which hydrochloric acid has been added, the involucral leaflets become of a beautiful ruby red colour. Further investigation showed this yellow pigment to be a hitherto undescribed quinone-like substance, which Rosoll has named *helichrysin*. In the younger leaflets it exists in combination with protoplasm, whilst in the older ones it has its seat in the residual cell-contents. Helichrysin is soluble in water, alcohol, ether, and organic acids; insoluble in benzol, chloroform, and carbon bisulphide; is coloured purple-red by mineral acids and alkalies; and is precipitated by metallic oxides and their salts as a red-coloured

* Comptes Rendus, xcix. (1884) pp. 51–3. Cf. this Journal, *ante*, p. 87.
† Chemical News, l. (1884) p. 37.
‡ Monatshefte, v. p. 94. Cf. Bull. Torrey Bot. Club, xi. (1884) pp. 94–5.

extract. The same body appears to be present in *H. orientale*, *H. fœtidum*, and *Statice Bonduelli*.

Passing to the fungi, the organs of fructification of *Peziza aurantia* with their yellow disk and lighter outer side, were examined. It was found that the orange colour is due to a new yellow pigment, that has been named *pezizin*, which is present in the form of extremely minute drops, combined with an oil-like substance that occurs dissolved in the plasma of the paraphyses. The pigment, which occurs also in *P. convexula*, may be dissolved out by alcohol or ether.

Saponin was ascertained to occur in the living roots of *Saponaria officinalis* and *Gypsophila Struthium*, dissolved in the cell-sap, from which it can be separated in small amorphous white particles by treatment of thin slices of the root with absolute alcohol or ether. In the dried roots and in quillaia-bark it occurs as an amorphous white or grey substance. By treatment with concentrated sulphuric acid and exposure to air, which gives rise to a yellow, then a bright red, and afterwards a beautiful blue-violet colour, saponin can be detected in the contents of all the cells of the middle bark of *Quillaia saponaria*.

Pure Chlorophyll.*—A. Tschirch regards as pure chlorophyll only such as agrees in its spectroscopic properties with the chlorophyll of living leaves. This definition will exclude the chlorophyll of chlorophyll tinctures, chlorophyllan, alkaline chlorophyll and its derivatives, the blue-green substance obtained by the reduction of phyllocyaninic acid by powdered zinc, and phyllocyanin. Solutions of chlorophyll are of practical value, in consequence of their innocuousness, for colouring articles of food or condiments, but the colour is not very permanent. This is due, in the case of alcoholic extracts, to the vegetable acids being extracted along with the chlorophyll, which at once cause its transformation into chlorophyllan, or, in the case of the drying of leaves, to the destruction of the protoplasmic envelope which served to protect it in the living plant. The colour of the chlorophyll can be best preserved unchanged by making an alkaline extract, in which case chlorophyllan is not formed, but chlorophyllinic acid, which combines with the alkali to form a more persistent beautiful emerald green salt, fluorescing a dark blood-red.

Lime and Magnesia in Plants.† — Observations on plants of *Phaseolus multiflorus*, by E. v. Raumer, show that the functions of lime are connected with the building up of the tissues and the formation of the cell-walls, but that it is not concerned in the formation or transformation of starch. The office of magnesia, on the contrary, is to assist in the starch-forming process, and the development of chlorophyll. Magnesia is always present in the latter, and its presence is necessary to healthy growth and colour.

* Arch. d. Pharm., xxii. p. 129. See Bot. Centralbl., xviii. (1884) p. 327.

† Bied. Centr., 1884, pp. 46–8. See Journ. Chem. Soc.—Abstr., xlvi. (1884) p. 917.

Easily Oxidizable Substances in Plant Sap.*—K. Kraus describes experiments made on the sap contained in the tubers of *Dahlia variabilis*, which he cut into slices. The surfaces gradually became yellow, and with longer time the colour penetrated below the surface; the bulbs swelled, turning green in the light, and pale green chlorophyll-bodies appeared. The yellow tinged cells contained a yellow or reddish sap; the surfaces of the slices were not only yellow but showed red points and streaks, whilst in the interior of the cells there was a red colouring matter turned green by alkalies. The author thinks the change of colour is due to oxidation.

Action of Nitrous Oxide on Vegetation.†—H. Möller claims to have determined, as the result of a series of experiments, that nitrous oxide has no directly injurious influence on living plants.

Silicification of Organs.‡—S. Miliarakis has examined the silicified hairs of *Deutzia scabra*, *Loasa vulcanica*, and a number of other plants, chiefly belonging to the Urticaceæ, with the view of ascertaining whether growth continues after the silicification has taken place, which question he answers in the negative. The cystoliths of *Ficus* and *Urtica* he finds to be usually surrounded by a siliceous envelope; and in *F. Sycomorus*, besides the ordinary cystoliths, are others completely silicified.

Influence of Solar Rays on the Temperature of Trees.§—E. Ihne inserted thermometers at different depths into the trunk of a maple tree, also in a branch and twig. He found that on a fine clear day the variations of temperature were not large, the exterior layers were higher than the interior, and the sections of larger diameter were the warmer; but on the whole the variations were slight, and the temperature at all times of observation a considerable number of degrees above that of the surrounding atmosphere.

Thermic Constants in Plants.‖—The thermal constant of a plant, according to Oettinger, is the sum of the mean temperatures of the days of active vegetation from the commencement of growth to some definite phase in the plant's life, minus a certain initial temperature, different for different species, and determined by comparing the observations of successive years. Staub objects to this, that the development of a plant depends not only on the aggregate quantity of heat which it receives, but above all on the temperature during growth, which cannot be expressed by adding together thermometric measurements.

* Bied. Centr., 1884, pp. 45-6. See Journ. Chem. Soc.—Abstr., xlvi. (1884) p. 918. Cf. this Journal, *ante*, p. 255.

† Ber. Deutsch. Bot. Gesell., ii. (1884) pp. 35-41.

‡ Miliarakis, S., 'Die Verkieselung lebender Elementar-organe bei den Pflanzen,' 30 pp., Würzburg, 1884. See Bot. Centralbl., xviii. (1884) p. 235.

§ Bied. Centr., 1884, p. 63. See Journ. Chem. Soc.—Abstr., xlvi. (1884) p. 917.

‖ Botan. Jahresber., iii. (1884) p. 131. See Journ. Chem. Soc.—Abstr., xlvi. (1884) p. 1067.

Chemical Changes in their Relation to Micro-Organisms.*—Prof. E. Frankland distinguishes between two kinds of chemical action—(1) that in which substances brought into contact mutually undergo chemical change, and (2) that in which chemical change is effected in one substance by contact with another, which itself apparently suffers no alteration.

The following definitions are proposed to distinguish animal and vegetable organisms:—(1) A plant is an organism performing synthetical functions, or one in which these functions greatly predominate; it transforms actual into potential energy. (2) An animal is an organism performing analytical functions, or one in which these functions greatly predominate; it transforms potential into actual energy. All micro-organisms appear to belong to the second class. Oxidation is the essential condition of life. There are, however, many other chemical transformations in which potential becomes actual energy, and which therefore can support life. The author describes the chemical changes produced by a large number of micro-organisms, and points out that there is no break in the continuity of chemical functions between micro-organisms and the higher forms of animal life. It is true there are apparently certain sharp distinctions between them. The enormous fecundity of micro-organisms and their tremendous appetites seem to separate them from the higher orders of animals. But this distinction is only comparative. It must be borne in mind that an animal like a sheep converts much of its food into carbonic acid, hippuric acid, and water, thus utilizing nearly the whole of the potential energy, while the micro-organism as a rule utilizes only a small portion. Those micro-organisms which have been chemically studied produce, like the higher animals, perfectly definite chemical changes. "The position of these organisms in nature is only just beginning to be appreciated. It may safely be predicted that there is no danger of their being spoiled by the petting of sentimentalists, yet these lowly organisms will receive much more attention in the future than they have done in the past."

B. CRYPTOGAMIA.

Cryptogamia Vascularia.

Comparative Morphology of the Leaf in Vascular Cryptogams and Gymnosperms.†—F. O. Bower points out that if the doctrine of Sachs and others that the living stem and leaf are to be regarded only as expressions denoting certain relationships of the parts of the *shoot*, be correct, the same mode of morphological treatment ought to be applied to both. In treating of the leaf, authors have not attached most importance to the mode of origin and sequence of appearance of its several parts; parts have been distinguished that are not morphologically co-ordinate. The author finds that there is no justification

* Nature, xxx. (1884) pp. 549–50. (Report of discussion at the Montreal Meeting of the British Association.)

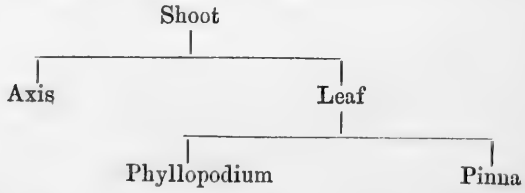
† Proc. Roy. Soc., xxxvii. (1884) pp. 61–5.

for this inconsistency in the mode of treatment of axis and leaf. The axis is, therefore, recognized by a distinct term, and the name *phyllopodium* is proposed for the main axis of the leaf, exclusive of its branches; the relation of the pinna to the phyllopodium is similar to that of the leaf to the axis. In complicated leaves we may distinguish a *hypopodium*, a *mesopodium* which is the equivalent of the petiole, and an *epipodium*, the equivalent of the upper part of the phyllopodium, exclusive of its branches. This method of study is shown to be natural by the investigation of the development of leaves in the lower vascular plants.

In a series of types of Vascular Cryptogams and Gymnosperms it was found that, in the simplest forms, the Hymenophyllaceæ, the branching is dichotomous; in most Leptosporangiate Ferns the branching of the leaf is at first monopodial; the Osmundaceæ are remarkable, and probably unique, for having the two-sided apical cell replaced by one which is three-sided and conical. In the Marattiaceæ the phyllopodium is from the first a solid structure. In the Cycadaceæ the apex of the phyllopodium is covered by a definite layer of dermatogen.

There is, then, a progressive differentiation of the phyllopodium as a supporting organ, and of other members of a higher order, which develope as flattened organs. That of the former will perhaps throw light on the mode of origin of the axis as a structure bearing leaves. "As the phyllopodium gradually asserts and, in the higher forms of the above series, maintains its identity among the branches of the leaf, so the axis may have differentiated itself as a supporting organ from among members similar to itself in origin and development."

Apical growth, which in the simpler forms is sometimes unlimited, becomes restricted as we ascend the series; in the higher vascular plants it ceases at an early stage, and there is a much greater degree of intercalary growth. It is concluded that the recognition of the phyllopodium and treatment of the whole leaf as a simple branch or as a branch system is in accordance with the true nature of the leaf as seen in all vascular plants. The relation of the pinnæ to the phyllopodium is similar to that of the whole leaf to the axis which bears it; and this may be thus shown in a tabular form:—



Apex of the Leaf in Osmunda and Todea.*—F. O. Bower has found in the young leaves of *Todea superba* and of *Osmunda cinnamomea* that the apex is occupied by a well-marked *three-sided*, conical, apical cell, from the three sides of which segments are cut off in regular

* Proc Roy. Soc., xxxvi. (1884) pp. 442-3.

succession. This cell is so placed that one side faces the ventral side of the leaf, while the remaining two sides are obliquely disposed with regard to the dorsal side of the leaf. No clearly marked marginal series of persistently active cells has been found giving rise to the pinnæ, as has been stated to be the case in typical ferns, and there appears to be no strict relation between the points of origin of the pinnæ and the segments cut off from the apical cell. The pinnæ arise in acropetal order. The presence of a three-sided apical cell in the leaf of a fern appears to supply an intermediate step towards the more complex leaf of the *Marantaceæ* and *Cycadeæ*, and it is believed that this is the first described case of a clearly marked three-sided apical cell occurring in the leaf of any plant.

Rabenhorst's Cryptogamic Flora of Germany (Vascular Cryptogams).—This division of the new edition of Rabenhorst's great work has been undertaken by C. Luerssen; and three parts of this most important contribution to cryptogamic literature are now issued. Luerssen classifies the Pteridophyta or Vascular Cryptogams under three classes, the Filicinæ, Equisetinæ, and Lycopodinæ. The Filicinæ are again divided into Isosporeæ and Heterosporeæ, and the Isosporeæ into Leptosporangiatæ (true ferns) and Eusporangiatæ (Ophioglossaceæ). In the parts now published the sub-order Hymenophyllaceæ is treated (one sp. only, *Hymenophyllum tunbridgense*), and of the sub-order Polypodiaceæ the genera *Polypodium*, *Gymnogramme*, *Notholæna*, *Cryptogramme*, *Adiantum*, *Cheilanthes*, *Pteris*, *Pteridium* (*Pteris aquilina*), *Blechnum*, *Scolopendrium*, *Athyrium*, and a part of *Asplenium*.

Muscineæ.

Braithwaite's British Moss Flora.—Since we last noticed this work,* Parts III.–VIII. have been published, including the Polytrichaceæ (5 pls.); Fissidentaceæ (3 pls.); Leucobryaceæ (1 pl.); Dicranaceæ (13 pls.); and Tortulaceæ, Part 1 (6 pls.).

It is hardly necessary to say that there is no falling off in the text or plates as the work progresses. It is fully up to the expectations formed concerning it before publication, and the text is in every respect worthy of the reputation of the author. He and the draughtsman divide between them the honour of the plates, which are perfect both in drawing and execution.

Hobkirk's British Mosses.†—This is a new edition of a now well-known handbook, which indeed is the only modern complete guide to the British Mosses. Of these 129 genera and 576 species are described, with full diagnostic characters and notes of locality. An alteration has been made in regard to classification, as the author no longer follows Bruch and Schimper (through Wilson), but adopts that of Jäger's 'Adumbratio Muscorum,' which, however, makes the preliminary synopsis by no means so simple. For collectors of British mosses the book is indispensable.

* See this Journal, iii. (1880) p. 670.

† Hobkirk, C. P., 'A Synopsis of the British Mosses,' 2nd ed., 8vo, London, 1884, 240 pp.

Characeæ.

Cell-division of Characeæ.*—A. Cagnieul has investigated the mode of cell-division in the cells of *Nitella intricata* and *opaca*, and does not agree in all respects with the observations of Johow.† It is true that in the cells of the internodes the division of the nucleus takes place by simple constriction, but this is never followed by actual cell-division. It is difficult to interpret in the same way the mode of division of the nucleus in the terminal cells of the stem and branches and in the nodal cells. In the mother-cells of the antherozoids the division of the nucleus can be followed with great ease. The increase in length of the filament composed of antheridial cells is always much more rapid than the multiplication of the cells themselves, from which it results that the longer axis of the cells is always very long in young antheridia, very short in those that are nearly mature. The nucleus has a very evident nucleolus, and after the application of reagents (chloride of mercury, picric acid, osmic acid, pigments, &c.), a moniliform filament of chromatin is seen. When segmentation is commencing and the nucleus is dilated, the filament of nuclein, now visible without the use of reagents, is sharply divided into fragments. Soon afterwards the nuclear plate is formed, and from this moment the spindle of segmentation, composed of a very large number of filaments of achromatin, is very clear. This spindle is almost always directed towards one of the diagonals of the optical view of the cell. In the next stage the cell-plate divides in two; and the two halves, composed of filaments curved into the form of a V, are directed towards the poles of the spindle; this latter at the same time turning on itself to an angle of 30° or 40°, until its axis coincides with that of the cell. The nuclear plate is soon formed, and a nucleolus makes its appearance in each of the newly formed nuclei.

Fungi.

Phosphorescent Fungi.‡—F. Ludwig has examined under the spectroscope the light given off by phosphorescent fungi, especially *Trametes pini*, *Agaricus melleus*, *Xylaria hypoxylon*, *Collybia tuberosa*, and *Micrococcus Pflugeri*, and finds its spectroscopic character to differ in different species. He maintains that the spontaneous phosphorescence is equal in intensity by day and by night.

Parasitic Hymenomycetes.§—According to H. Mayr, the two species of *Polyporus* found commonly on birch-stems, *P. betulinus* and *P. lævigatus*, are true parasites, the mycelium which springs from the spores having the power of penetrating uninjured living cells and turning their contents brown. The mode in which this parasitism is effected is described in detail in both species. The author describes the singular phenomenon that when both parasites attack the same stem, a solid dark-brown hard division-wall is formed, separating the two entirely from one another.

* Bull. Soc. Bot. France, xxxi. (1884) pp. 211–3.
† See this Journal, ii. (1882) p. 79.
‡ Zeitschr. f. Wiss. Mikr., i. (1884) pp. 181–98.
§ Bot. Centralbl., xix. (1884) pp. 22–9, 51–7 (2 pls.).

Mode of Bursting of the Asci in the Sordarieæ.*—W. Zopf has investigated the mode in which the ascospores are expelled from the ascus in this section of the Pyrenomycetes, by placing the perithecia, entirely intact, with the substratum, in a drop of water, when the expulsion can be watched in all its stages. When ripe the asci are nearly cylindrical, but slightly apiculate, and shortly stalked. At the commencement of the ejection of the spores they gradually lengthen, and also become considerably wider in their upper part, the lengthening going on until the apex of the ascus projects, in the form of a beak, through the neck-canal of the perithecium, and even beyond its opening. At this moment the ascus suddenly bursts below its apex, and the spores are ejected into the water, the rest of the ascus shrivelling up, and the spores remaining attached in a row. The numerous asci in the perithecium expel the spores successively in the same way. The spores in all cases remain attached in a single mass to the apex of the ascus, and in one or more rows, according as their number is 4, 8, or 64 in an ascus. In the sub-genera *Eusordaria* and *Bertia* this is effected by means of a tail-like appendage at each end of each spore, by which they are all attached together; in *Hypocopra* and *Coprolepa* by means of a gelatinous envelope inclosing the whole mass of spores; and in each case they are by the same agency firmly attached to the apex of the ascus. This appendage to the spores is not, as was supposed by Woronin, a thickening of the membrane of the spores themselves, but is derived from a portion of the protoplasm of the ascus not used up in the formation of the ascospores; and the gelatinous envelope is due to the same origin. The paraphyses within the ascus play also some part in the ejection of the ascospores, by giving a direction to the course of growth of the ascus, by serving as a reservoir of water, and by exercising a direct pressure on the ascus, and thus assisting in its rupture.

Actinomyces.†—H. Karsten describes the structure of this parasitic fungus, which is found chiefly as an endophyte in the tongue and jaws of cattle. Organisms agreeing with certain conditions of development of this parasite are also found in swine and in men. *Actinomyces* makes its appearance in the form of globular pale yellow tufts, consisting of a quantity of interlacing branches, about 1 mm. or more in diameter. These tufts readily break up into a number of wedged-shaped pieces, consisting of a pedicel-cell which divides into from two to nine short branches, each bearing at its apex from one to three bodies described by Harz as gonidia, but which may possibly be bodies containing gonidia. In the jaw-bones of cattle occur forms with slenderer hyphæ and smaller gonidia, the result probably of insufficient nutriment, and these agree with the forms found in swine and in men.

* Zopf, W., 'Zur Kenntniss d. anatom. Anpassung d. Pilzfrüchte a. d. Funktion d. Sporenentleerung,' Halle, 1884. See Biol. Centralbl., iv. (1884) p. 385.

† Flora, lxviii. (1884) pp. 393–6.

Harz, the discoverer of this fungus, places it in the Hyphomycetes, a section of Gonidiomycetes; but Karsten regards it as having greater affinity with *Entomophthora* and *Exobasidium*.

Rhizomyxa, a New Phycomycete.*—A. Borzì describes a new parasitic fungus, found on the roots of a large number of herbaceous plants, especially on those of *Capsella bursa pastoris* and *Stellaria media*. The vegetative body of *Rhizomyxa* consists of a simple naked plasmodium, with scarcely differentiated parietal layer, and with from 10 to 30 small nuclei, granules of protoplasm, and vacuoles; the plasmodium approximating very closely in form to that of the cell on which it lies, even when this is an elongated root-hair. As soon as the parasite has consumed the protoplasm of this cell, its reproduction commences, which takes place in two ways, asexually by swarm-cells and spores, sexually by fertilized oospores.

The formation of swarm-spores takes place by the transformation of the entire plasmodium into a zoosporangium. It contracts somewhat and invests itself with a thin wall of cellulose, the contents become homogeneous and finely granular, and the vacuoles disappear. The nuclei increase rapidly by division, and the whole of the protoplasm breaks up into a number of portions, which escape from the zoosporangium and the nutrient cell, and become zoospores. The escape is effected by means of a protuberance from the zoosporangium, which pierces the wall of the adjoining cell. The zoospores are spherical, with a short beak and one cilium, colourless, and contain a small nucleus. Their motion is not affected by light, and lasts for about a quarter of an hour. They then either perish, or, if in favourable circumstances, perforate the wall of the cells of the root or of root-hairs; they become invested with a thin cell-wall, out of which the protoplasmic contents escape in the form of an amœba into the cell of the host; and this myxamœba then developes into a new plasmodium. This may then again produce zoospores or ordinary spores, which are at first naked masses of protoplasm, but afterwards become invested in a cell-wall. These spores may then either develope into small zoosporangia containing only one or two swarm-spores, or their cell-wall becomes very thick, and a mass of them hibernates within the host in the form of a cystosorus, resembling that of *Woronina polycystis*. Their further development was not observed.

The sexual reproductive organs spring from plasmodia in no way different from those that produce swarm-spores. The plasmodia destined for this purpose become elongated and at length assume a club-shaped form. This then divides by a wall of cellulose into two cells, a larger spherical one, the oogonium, and a smaller oval one, the antheridium, which remain attached to one another; both contain several nuclei. The protoplasm of the oogonium now becomes differentiated into two layers, separated by a thin membrane, the central denser one of which is the oosphere, and alone takes part in the impregnation. The antheridium then puts out a cylindrical protuberance, which enters

* Borzì, A., 'Rhizomyxa, nuovo Ficomicete,' 53 pp. (2 pls.) Messina, 1884. See Bot. Centralbl., xix. (1884) p. 1.

the oogonium, attaches itself firmly to the investing membrane of the oosphere, finally pierces it, and the entire contents of the antheridium becomes absorbed by the oosphere, which now becomes invested with a double membrane, and assumes the character of an oospore.

The systematic position of *Rhizomyxa hypogœa* is regarded by Borzì as referable to the Ancylistaceæ, near to *Lagenidium*, *Mycocytium*, and *Achlyogeton*; but it also has many points of resemblance to the Chytridiaceæ, especially to *Woronina* and *Olpidiopsis*.

Effect of Light on the Cell-division of Saccharomyces.*—L. Kny has carried on a series of experiments on this subject, as the result of which he comes to the conclusion that cell-division takes place in *Saccharomyces cerevisiæ* as actively in moderate light as in darkness.

Behaviour of Blood-corpuscles to Pathogenous Micro-Organisms.† — The observations which E. Metschnikoff has made on *Daphniæ* have given results, which, if they are confirmed, seem to be of the greatest importance in the knowledge of parasitic diseases and their treatment.

The author observed a disease in the *Daphniæ*, produced by the penetration and development of a fungus which eventually kills the host. Inoculation experiments on healthy *Daphniæ* showed that the cells of the fungus were attacked by the blood-corpuscles in the interior of the organisms, and finally overcome. Both spores and gonidia showed changes of form which resulted in their complete destruction. On the other hand, the blood-corpuscles suffered from the parasites, as some of them were seen to burst up into several pieces, whereby the gonidia were freed from the parent-cell. It was further observed that blood-corpuscles in the neighbourhood of fungus cells dissolved and completely disappeared. The number of the blood-corpuscles dissolved increased in proportion to the advance of the disease.

Metschnikoff concludes from his observations that "the infection and disease of the *Daphniæ* consist in a struggle between two living organisms, the fungi and the blood-corpuscles. The former are lowly organized unicellular plants; the latter are the lowest tissue-elements, and show the greatest resemblance to the simplest organisms." The issue of this struggle varies at the commencement of the infection by spores, the latter are mostly killed, and the blood-corpuscles obtain the upper hand. But when the disease has already broken out, the parasites gain the mastery. The first is generally observed in mature *Daphniæ*, which, although capable of infection, do not commonly take it; the second in young individuals which generally succumb to the parasite.

Metschnikoff connects these results with some observations on the diseases caused by fungi in the higher animals.

* Ber. Deutsch. Bot. Gesell., ii. (1884) pp. 129-44.

† Arch. f. path. Anat. u. Physiol., xcvi. (1884) p. 177. See Naturforscher, xxvii. (1884) p. 232.

Micrococci of Pneumonia.*—F. Strassmann has a brief communication on his experiments with the sputa of pneumonia patients, which started with the view that, if the fungi are, as Friedländer has shown, most richly and regularly found in the bronchial exudation of the dead body, they ought also to be found in that which is expectorated during life. The author found that his expectation was fulfilled. In the examination of a number of non-pneumonic sputa diplococci were found, which apparently came from the buccal cavity; these are only with difficulty to be distinguished from the micrococci of pneumonia. As the cocci of pneumonia are to be found twenty-four or thirty-six hours after the crisis, the author thinks that they do not suddenly disappear, like the spirilla of recurrent fever.

Micro-organism of Zoogloïc Tuberculosis.†—L. Malassez and W. Vignal have now succeeded in satisfactorily staining zoogloeæ, and they find that those that are best stained are small isolated zoogloeæ; others can only be partly coloured, the staining affecting only their periphery; others, again, cannot be stained at all. The authors think that the parts susceptible of colouring are those which have been most recently developed, and which are in the best condition of nutrition.

Stained specimens were seen to consist of a mass of small elongated grains, ·6 to 1 μ long and ·3 μ wide; they are disposed in linear rows, which are looped, and cross one another; the grains are micrococci. Differences in coloration were seen to be associated with notable differences in structure. In the periphery of zoogloïc tuberculosis one may see (1) very small zoogloeæ, which only differ from those just described by their smaller size, and by forming masses less dense, and of less regular contour; (2) long undulating bands, which are often curved; (3) very short rectilinear groups, which are either isolated or united into small masses; (4) diplococci and micrococci, either isolated or in groups.

The similarity in structure and the existence of intermediate forms proves that all the various kinds belong to the same micro-organism as the large zoogloeæ; and this view is confirmed by a study of their development. The series starts with the micrococci and diplococci. Loss of colourability, dissociation of the mass, the conversion of the elongated into spherical micrococci, and the increase in the amount of the interstitial substance, are signs that the parasite is dead, or has passed into a condition of latent activity.

The fact that granulations in which, till the use of their new methods, no zoogloeæ could be distinguished, can now be seen to contain micrococci, and that sometimes small masses or long chains do not become stained, seem to the authors to show that the zoogloïc organism need not always pass through the whole of its development before passing into the latent stage, and leads, too, to the suggestion that there may be lesions in which all these small forms would remain uncoloured, in which case they would doubtless escape detection, and the nature of the tuberculosis would be misunderstood.

* SB. Jenaisch. Gesell. f. Naturwiss., 1883 (1884) pp. 16-17.

† Comptes Rendus, xcix. (1881) pp. 203-5.

Microbe of Typhoid Fever of Man.*—M. Tagon commenced his experiments on the microbe of typhoid fever by injecting the blood from a patient dead of typhoid under the skin of rabbits, pigeons, and other animals; the malady was never transmitted. Drinking of the blood did not have mortal effects, nor did other direct means of poisoning have any result. It was different, however, when the microbes were cultivated in various liquids. At the end of twenty-four to forty-eight hours the typhoid microbe rendered turbid the cultivation fluid; if this was injected under the skin of the rabbit, white rat, or pigeon it had no effect; the dog or cat might be attacked by a mortal disease, but the guinea-pig died within a period varying between twenty minutes and forty to forty-five hours; in the last-named animal the characteristic lesions were always to be detected. The blood of a guinea-pig so killed was not mortal to other guinea-pigs, nor to rabbits, cats, or pigeons; but if a drop is cultivated it is soon very virulent towards other guinea-pigs, and dangerous for dogs or cats, but indifferent to the rabbit or pigeon. After several successive passages in cultivation and in the body of a guinea-pig, the microbe becomes certainly mortal to cats a month old. The blood of such a cat is very virulent for rabbits only, but the blood of a poisoned rabbit will not kill other rabbits until, at any rate, it has been cultivated.

The typhoid microbe is then "un petit être à transmission," just like certain parasites which pass part of their existence in one and the rest in another animal. It differs from the microbe of anthrax, or chicken-cholera, or the septic vibrios which are reproduced without transition in one organism; it has a more complicated life-history, for two appropriate media are necessary to its existence.

Under the Microscope, with a magnifying power of 1000 diameters, it has the form of small granulations and of short and very mobile rods, which, were it not for their small size, would have a considerable resemblance to the septic vibrio; some of the granulations have very fine prolongations, which are extremely mobile; in other cases there are rounded spores and short rods, which may be seen to segment, and to produce granulations in their interior and at their extremities.

Bacillus of Cholera and its Culture.†—An outbreak of cholera last July at Bonn gave Prof. Finkler and Dr. Prior an opportunity of applying Koch's method to the study of the comma-shaped bacillus which showed a remarkable resemblance to that of Asiatic cholera cultivated by Koch. It was found associated with large masses of the spiral-shaped organism, but with no other germ of specific appearance. These forms could not be detected in preparations of normal or any other pathological excreta under the same method of treatment. But after several failures a comma bacillus was obtained, which in its nourishment, period of evolution, and temperature, behaved exactly like

* Comptes Rendus, xcix. (1884) pp. 331–4.

† Nature, xxx. (1884) p. 626. Report of the Magdeburg Meeting of the Association of German Naturalists and Physicians.

corresponding cultures obtained by Koch from true cholera. Still, differences occurred in respect of the successive stages of evolution, which inferentially affects the question of the permanent form of the germs. After some time they become thicker, and assume the form of a whetstone, while at both extremities spore-like forms make their appearance, and take the shape of spore-bearers. Both spores are presently extruded from the spore-bearers, and begin to crawl about under the Microscope. They assume the form first of straight, then of crooked rods, which develope into spirals of diverse shape, length, and curvature. Becoming thicker and swollen, these spirals in their final evolution seem to consist exclusively of small comma bacilli. But whereas the comma of Asiatic cholera, at least according to Koch's investigations, develops no permanent form, these acquire a stability in the spore state capable of resisting the process of putrefaction. Their behaviour, however, when being desiccated or subjected to chemical agents has not yet been tested by Professor Finkler. Between the prepared specimens of cholera nostras and true cholera bacilli exhibited under the Microscope, no optical difference could be detected. Owing to the attitude of most German physicians, who regard it as a patriotic duty to hold Koch's doctrine as unassailable, while the German scientific journals persistently ignore the objections urged by eminent foreign investigators against the theory, Prof. Finkler's statements have naturally excited considerable sensation. In any case a severe blow was given to the assumption of Koch's infallibility, although Prof. Finkler and Dr. Prior have so far failed to determine the true pathogenetic and pathognostic functions of their cholera nostras comma bacillus, as completely as Koch has for his Asiatic cholera comma bacillus.

Prof. E. Ray Lankester* does not "hesitate to say: (1) that Koch's comma bacillus is *not* comma-shaped; (2) that it is *not* a bacillus but a spirillum; (3) that although it does sometimes (but not always) occur abundantly in the intestines of cholera patients, there is not a tittle of evidence to show that it causes cholera, no experimental attempt to produce cholera by its agency having succeeded. These conclusions are derived from Dr. Koch's own statements. While Dr. Koch is, as was to be expected, perfectly candid and convincing in the account which he gives of his observations, the extraordinary feature in his report is the dogmatic declaration that this organism, which is not in any way proved to possess disease-producing powers, nevertheless must and shall be henceforth regarded as the cause of cholera. Dr. T. Lewis, who for many years studied microscopically the intestines and evacuations of cholera patients in Calcutta, has demonstrated, since the publication of Koch's report, that the so-called comma-shaped bacillus is identical in form with one occurring commonly in the mouths of healthy persons."

Dr. Koch is said to have succeeded in communicating cholera to a number of rabbits by inoculating them with pure cultures of the

* Pall Mall Gazette, 6th October, 1884, pp. 1-2. See also 'Times,' 19th Nov., 1884.

"comma" bacillus. The rabbits at any rate sickened and died with symptoms resembling those of cholera, and the intestines were found to be infested with the "comma" bacilli.*

On the other hand Dr. Klein, who is studying the cholera question in Calcutta, is reported to be satisfied that Koch's bacillus is not the cause of the disease, and has swallowed a number of the microbia without any evil results.†

Influence of Culture Fluids and Medicinal Reagents on the Growth and Development of Bacillus tuberculosis. —Dr. C. T. Williams gives the results of a series of experiments the object of which was to determine the conditions under which the *Bacillus tuberculosis* Koch grows and multiplies, and to examine its behaviour under the influence of certain medicinal agents and reputed antiseptics.

The sputum of patients in advanced phthisis was used for experiment, spread on cover-glasses, the staining process employed being the Weigert-Ehrlich modification of Koch's original method.

Between 200 and 300 specimens were thus examined with an Abbe condenser and an F (1/12) immersion lens, giving a magnifying power of 550 diameters. Higher powers up to 1390 diameters were employed for investigating the structure of the bacilli.

The methods adopted to ascertain the increase or diminution of the bacilli were:—1st, to count the numbers present in a series of fields of view, at least six, and often twelve, being counted, and in doubtful cases the whole slide was carefully gone over before a conclusion was arrived at; 2nd, to note the length of the bacilli and the presence or absence of well-marked divisions in these preceding their multiplication; 3rd, to observe whether the bacilli were isolated or in groups.

In every case a standard for comparison was first taken from the sputum and the number of bacilli counted; the rest of the sputum was divided into portions of 20 to 30 minims, mixed with solutions of various medicinal and other agents, and then kept in a Page's incubator at a uniform temperature of 38° C., for periods of from forty-eight hours to eight days.

The following cultivation fluids were used:—

Syrup solution of the strength of 2 drachms of syrup to 1 ounce of water; hay infusion; Pasteur's solution (without sugar); beef solution, 1 ounce of meat to 2 ounces of water; beef solution, ½ ounce of meat to 2 ounces of water; pork broth (Klein); also distilled water and the subjoined medicinal agents in solution were mixed, in generally equal proportions, with the sputum, and kept at the same temperature as above; solutions of quinine in strength varying from 2 gr. to the ounce to 10 gr. to the ounce; solutions of arsenous acid ½ gr. to the ounce, and 1 gr. to the ounce; solutions of boracic acid, 1 part in 30 and 1 part in 15; solutions of iodine, 1 part in 12; solutions of perchloride of mercury, 1 gr. to the ounce.

* Micr. News, iv. (1884) p. 290.
† Journ. of Sci., vi. (1884) p. 694.
‡ Proc. Roy. Soc., xxxvi. (1884) pp. 510-2.

The result of the experiments showed that the tubercle bacillus is characterized by great durability of structure, as evidenced by its not being destroyed by the strong acids used in the various processes for its detection, and by its little tendency to decomposition. It does not multiply in distilled water, but does so largely in beef solutions. Arsenic, boracic acid, and perchloride of mercury do not interfere with its development, but rather promote it. Quinine and iodine (especially the former) appear to entirely arrest its growth and destroy its power of multiplication.

Chemical Properties of Bacillus subtilis.*—G. Vandevelde finds that *B. subtilis* is an organism which can live in the ferment-stage for a long time. He was induced to investigate the subject by the contradictory statements that had been made; to obtain the organism he adopted the method of Roberts and Buchner, which consists in immersing hay in as small a quantity of water as possible, and maintaining it for about four hours at a temperature of 36°; the liquid having been poured off and brought to a density of 1004, is placed in vessels of which it fills only half; these, after having been firmly closed, are subjected to heat sufficient to boil the water; the water is then kept for an hour at a temperature of 36°, and after thirty hours there is a rich supply of *B. subtilis*. The organism multiplies rapidly in a suitable cultivation-fluid, and the author thinks that it does so at the expense of the dissolved oxygen; when this is used up the microbes make their way to the surface, where they live and multiply by absorbing oxygen. Experiments made with various chemical reagents proved that the microbe was able for long to play the part of a ferment; if the experiments of Buchner should be confirmed, the transformation of *Bacillus anthracis* into *B. subtilis* is the transformation of an organism that can only live for a short time without free oxygen into another which can for a long time produce the heat necessary for its life while decomposing fermentescible substances. *B. subtilis*, after it has transformed carbohydrates into lactic acid, has a strong tendency to form butyric acid at the expense of the lactic.

Vandevelde has been able to detect nuclein in *B. subtilis*, but he has not yet found any traces of cellulose.

Supposed identity of Hay-bacteria and those of Cattle-distemper.†—A. Prazmowski contests the view of Buchner ‡ that these two bacilli are different forms of development of the same organism. By careful culture he claims to have observed important points of difference in their structure and development.

In the hay-bacterium, *B. subtilis* Cohn, the rods, whether isolated or united into chains, grow into long segmented or unsegmented pseudo-filaments, which form a pellicle on the fluid, and in which the spores are formed, each segment of the pseudo-filament elongating, and forming within it an elongated strongly refractive spore. These

* Arch. Biol., v. (1884) pp. 127–51.
† Biol. Centralbl., iv. (1884) pp. 393–406.
‡ See this Journal, iii. (1883) p. 832.

become free by the dissolution of the membrane of the mother-cell, fall to the ground, and germinate when brought into a suitable nutrient fluid. After from one to two hours the spores swell to twice their volume, lose their refrangibility, and put out the young rod laterally, i. e. at right angles to the longer axis of the spore. This rod then lengthens rapidly, frees itself from the membrane of the spore, and swims free, the membrane showing evident thickenings at both ends.

The bacterium of cattle-distemper, *B. anthracis*, exhibits several variations from this in its development, and especially in the mode of germination. Under similar conditions to those of *B. subtilis* the spores of *B. anthracis* lose their refrangibility much more rapidly, and in the course of 15 or 20 minutes, swell up to several times their original volume. They then present a close resemblance in appearance to the young rods of *B. subtilis;* but they germinate only after from one to two hours, and then the young rod always breaks through the spore-membrane at both ends, growing in the direction of its longer axis, then growing rapidly and increasing by division. After attaining a certain length it throws off the membrane, which is a thin delicate envelope of equal thickness throughout.

Although regarding these two forms as distinct species, Prazmowski agrees with Buchner and Pasteur in stating that, under certain conditions of culture, the bacteria of cattle-distemper may produce non-pathogenous forms agreeing with the pathogenous in their morphological characters and the history of their development.

Bacterioidomonas sporifera.*—Under this name J. Künstler describes a parasite inhabiting the cæcum of *Cavia*, and possessing characters that connect it with the Schizomycetes as well as with the animal kingdom. In outward appearance it presents an oval form slightly flattened from head to tail, and when fully developed attains a length of about 24 μ. It progresses tolerably rapidly and with a rectilinear movement by means of a long flagellum implanted at the anterior end of the body. When once the difficulty of staining it with reagents is overcome its structure under a high power is seen to consist of a peripheral layer forming an enveloping membrane of nitrogenous nature, and a pale protoplasmic interior presenting a finely stippled aspect. In the centre is a rounded corpuscle of finely stippled protoplasm, destitute of nucleolus, and presenting none of the characters which render certain nuclei so complex. This nucleus is not always single, individuals frequently being found which have one at each extremity.

Reproduction takes place by the development of spores within the interior of the body, whence they are liberated through the rending of the body-wall. A flagellum subsequently forms, and they would appear to be capable of increase by division. Ordinarily they twist themselves little by little into a tendril-like form, when they resemble a thick *Spirillum*.

The nutrition of *Bacterioidomonas* takes place by imbibition; no

* Journ. de Microgr., viii. (1884) pp. 376-80 (1 pl.).

trace of buccal opening being observed, and the substance of the body never contains foreign corpuscles. The excess of nutritive material absorbed is disposed in the protoplasm under a peculiar and remarkable form—like dissolved starchy material, that turns blue by the action of iodine.

Bacterioidomonas sporifera has, the author thinks, "perhaps a common origin with the Bacteria; but its evolution has not followed the same direction, and it has retained some of the essential appanages of animality."

Rabenhorst's Cryptogamic Flora of Germany (Fungi).—The two most recent parts received of this publication (14 and 15) commence the description of the Ascomycetes. The Gymnoasceæ are treated in full, including the genera *Exoascus* (13 species), *Endomyces*, *Eremascus*, *Gymnoascus* (3 species), and *Ctenomyces*. Next in order come the Pyrenomycetes, beginning with the sub-order Perisporiaceæ, divided into the two families Erysipheæ and Perisporieæ, and including the genera *Sphærotheca*, *Erysiphe* (11 species), *Podosphæra*, *Microsphæra*, *Phyllactinia*, *Uncinula*, *Thielavia*, *Dimerosporium*, *Magnusia*, *Cephalotheca*, *Zopfiella*, *Anixia*, *Eurotium* (8 species), *Aspergillus* (4 species), *Penicillium* (1 species), *Zopfia*, *Perisporium* (15 species), *Lasiobotrys*, *Apiosporium* (15 species), *Capnodium*, *Asterina*, and *Microthyrium*. The Hypocreaceæ are carried on as far as the genus *Nectria*.

Worthington Smith on Diseases of Field and Garden Crops.*—Under this title W. G. Smith publishes an exceedingly useful account of the majority of the diseases to which plants are subject, especially those caused by fungi, but including also the ailments due to the attacks of nematoid worms; as well as a very full description of the parasitism of the clover-dodder. It is copiously illustrated by woodcuts.

Myxomycetes with Pseudo-plasmodia.†—O. Brefeld proposes to divide the Myxomycetes into two principal types:—Myxomycetes aplasmodiophori, forms without any plasmodium or with pseudoplasmodia; and Myxomycetes plasmodiophori, forms with true plasmodium. The former are undoubtedly the simpler type, and may be again divided into the Guttulinæ with sessile, and the Dictyosteliaceæ with stalked sporangium. The Guttulinæ, which occur on dung in various forms, are the starting-point of the Myxomycetes, and must be regarded as among the simplest forms of Thallophytes.

The Dictyosteliaceæ consist of the two genera *Polysphondylium* and *Dictyostelium*, of which Brefeld describes in detail two species, *P. violaceum* and *D. mucoroides*.

Polysphondylium, a new genus established by Brefeld, differs from *Dictyostelium* in its verticillate lateral branches, springing from

* Smith, W. G., 'Diseases of Field and Garden Crops,' 353 pp. 8vo, London, 1884.

† Brefeld, O., 'Unters. aus d. Gesammtgeb. der Mykologie,' Heft 6, pp. 1–34 (2 pls.). See Bot. Centralbl., xviii. (1884) p. 193.

beneath the terminal violet sporangium; it occurs on horse-dung. The amœbæ appear among the spores in the same way as in *Dictyostelium*, and are provided with vacuoles and a nucleus. These amœbæ do not, however, coalesce into a true plasmodium before the formation of the sporangium; they can be separated from one another by the slightest pressure, and constitute what may be termed a pseudoplasmodium, from which the sporangium is directly formed. Almost before the amœbæ have entirely lost their pseudopodia the formation of the sporangium begins; a central portion of the mass of amœbæ becomes differentiated, and developes into the pedicel, each amœba becoming a pedicel-cell. As soon as the formation of the pedicel is completed, the remaining mass creeps to its apex and collects into a ball; each amœba becomes a spore, and the whole a pseudosporangium, which is at no time enveloped in a membrane.

Lichenes.

Relation of Lichens to the Atmosphere.*—G. Bonnier and L. Mangin have determined that under circumstances most favourable to their development, viz. in darkness, diffused light, sunshine, and at different temperatures from 10° to 32°, several lichens—*Cladoma rangiferina*, *Evernia Prunastri*, *Parmelia caperata*, and *Peltigera canina*—display, as the net result of the influence on them of the air, an absorption of oxygen and disengagement of carbon dioxide. It follows that, under the most favourable conditions, the action of chlorophyll does not compensate respiration; and that, as a consequence, lichens cannot obtain from the atmosphere all the carbon which they require for building up their tissues.

Algæ.

Algæ of the Red Sea.†—A. Piccone publishes a list of 235 algæ found in the Red Sea, mostly in the Bay of Assab, with descriptions of a number of new species and varieties. Four genera and not less than 99 species are peculiar to the Red Sea algal flora; and the general affinities are much closer with the forms of the Indian Ocean than with those of the Mediterranean. The great feature of the algology of the Red Sea is the enormous number of species and varieties of *Sargassum*, nearly all of them endemic; it is also characterized by the scarcity of diatoms, and of green algæ generally; the Laminarieæ are also altogether wanting.

Afghanistan Algæ.‡—Dr. J. Schaarschmidt gives an annotated list of 60 species of algæ collected in Afghanistan in 1880. They were found chiefly adhering to specimens of *Ammannia pentandra* Roxb., and forming fine bluish-green incrustations around the stems and on the leaves. Many interesting forms were found (perhaps

* Bull. Soc. Bot. France, xxxi. (1884) pp. 118–9.
† Nuov. Giorn. Bot. Ital., xvi. (1884) pp. 281–332 (3 pls.).
‡ Journ. Linn. Soc. Lond. (Bot.) xxi. (1884) pp. 241–50 (1 pl.).

Bacillariaceæ) in the small earthy particles remaining attached to the roots. One species, viz. *Hantzschia Amphyoxys*, was only found on the roots of *Anemone tetrasepala* Royle.

Conjugatæ.*—F. Gay publishes a monograph of the Conjugatæ of the neighbourhood of Montpellier. He describes the mode of growth as twofold: the ordinary growth of the Zygnemeæ and Mesocarpeæ, and the local growth or "reduplication" of the Desmidieæ. The modes of reproduction described are: parthenogenetic, as seen by Wittrock in the Mesocarpeæ, and by the author in *Spirogyra longata;* apogamous, also described by Wittrock and De Bary; and the ordinary sexual mode.

Floating Rivularieæ.†—E. Bornet and C. Flahault review all the algæ belonging to the Rivularieæ described as forming "flos aquæ," and conclude that they must all be referred to the genus *Glœotrichia*, many of them being forms of the species known as *G. pisum*. *Glœotrichia* is reproduced in two ways: by hibernating spores and by hormogonia. Algæ belonging to this group are much more constant in their form than Nostochineæ, such as *Tolypothrix*, *Scytonema*, and *Lyngbya*.

Sphacelaria.‡—V. B. Wittrock finds the rare alga *Sphacelaria cirrhosa β ægagrophila* Ag., on the east coast of Gothland, in the form of globular balls, 1–4 cm. in diameter, not attached, but rolling about free in the water. The balls consist of an immense number of radial threads matted together by their numerous branches, these are collected into two or three concentric layers, each of which appears to be the growth of a year. Two other algæ, a diatom and a *Cladophora*, are epiphytic on the *Sphacelaria*, and unite with it to make up the floating ball.

"Sewage-Fungus."§—A. W. Bennett has examined the organism known by this name to sanitary engineers, which appears in white flocculent masses in the effluent water from sewage works. He finds it to be identical with *Beggiatoa alba* Vauch., or a variety of that species, which is characterized by the remarkable property of eliminating sulphur from the organic or other substances present in the water. This sulphur appears as minute strongly refringent globules inclosed within the colourless filaments, and generally situated near to a transverse septum or the base of a branch-filament.

Growth of the Thallus of Coleochæte scutata.‖—L. Kny states that in the disk-like thallus of this alga attached to the sides of vessels, cell-growth and cell-division almost invariably take place more actively on the side most exposed to the light. He does not,

* Gay, F., 'Essai d'une monographie des Conjuguées' (4 pls.) Montpellier, 1884. See Bot. Centralbl., xviii. (1884) p. 353.

† Bull. Soc. Bot. France, xxxi. (1884) pp. 76–81.

‡ SB. Bot. Gesell. Stockholm, Feb. 27, 1884. See Bot. Centralbl., xviii. (1884) p. 283.

§ Proc. Brit. Assoc. Adv. Sci. (Montreal Meeting) Sept. 2, 1884.

‖ Ber. Deutsch. Bot. Gesell., ii. (1884) pp. 93–6.

however, consider that this is due to the direct influence of light, but only indirectly, in the same way as Famintzin has shown in the case of *Spirogyra*.

Influence of Gravitation on the Movements of Chlamydomonas and Euglena.*—F. Schwarz has tried a series of experiments on this subject, from which he concludes that gravitation is the determining cause of the direction of the movements of *Euglena* and *Chlamydomonas* in the dark under certain conditions. This may take place in two ways:—Firstly, gravitation may act in the same way as light—as a stimulant, i. e. these organisms may be sensitive towards gravity in the same way as they are towards light; gravitation brings forces into play which place their longer axis in a certain direction, in which direction movement then takes place. Secondly, the objects may place themselves, in consequence of the excentric position of their centre of gravity, in the resting position, so that the anterior colourless end is turned upwards; gravitation would in this case cause an upward motion without acting as a stimulant.

If the calling forth by gravitation of phenomena of movement and growth is called geotropism, these movements may be regarded as geotropic; but the author proposes for this special phenomenon the term *geotaxis*, corresponding to the similar phenomenon of phototaxis produced by light.

Chytridiaceæ.†—K. Fisch has observed three new forms of Chytridiaceæ growing on green water-plants, one of them the type of a new genus.

The new genus (*Reesia*) is distinguished from all other genera of the order by the possession of zygospores, and is thus characterized:—Vegetative structure amœboid; reproduction by zoosporangia, with long neck projecting into the water, and uniciliated zoospores, which conjugate in pairs and produce resting-spores; these, on germinating, give birth to zygospores, which penetrate singly into the host. In addition to these zoospores are others not differentiated sexually which produce these reproductive organs directly. *R. amœboides* lives in the cells of *Lemna*.

The genus *Chytridium* he thus defines:—Zoosporangia of various forms and opening in various ways; zoospores not conjugating; in the summer producing again zoosporangia, in the autumn resting-spores; the latter, on germination, again producing non-conjugating zoospores.

Rhizidium has zoosporangia and resting-spores formed from a strongly developed much-branched cell or mycelium; zoospores not conjugating; secondary zoosporangia and resting-spores often produced in intercalary and terminal positions.

Fisch regards *Reesia* as the lowest form of the Chytridiaceæ, which he considers as related to the Ustilagineæ, through *Protomyces* as a connecting form, rather than with the Peronosporeæ.

* Ber. Deutsch. Bot. Gesell., ii. (1884) pp. 51–72.

† Fisch, K., 'Beiträge zur Kenntniss der Chytridiaceen.' Erlangen, 1884. See Bot. Centralbl., xviii. (1884) p. 225.

Some further description is also given of *Pleocystidium parasiticum*, found in the cells of *Spirogyra*, which he regards as belonging to no recognized group, but most nearly related to the Chytridiaceæ.

Cooke's Fresh-water Algæ.—Dr. M. C. Cooke has now completed this excellent work, which no microscopist can be without. It includes descriptions and coloured plates of all the fresh-water algæ at present found in the British Islands, exclusive of diatoms and desmids.

Alga in Solutions of Sulphate of Magnesia and of Lime.*—Prof. E. Perceval Wright found a minute phycochromaceous alga in test solutions of sulphate of magnesia and of lime and of phosphate of soda, which, in certain lights, presented quite a green shade. These solutions were kept exposed to light, and were prepared with all due care. The algal form abounded in all, but in the phosphate of soda it developed much more rapidly, so as to present, on the solution being shaken up, a dense flocculent cloud. The form seemed allied to *Chroococcus*, and was immensely active in its cell-division and cell-growth.

Confusion between Species of Grammatophora.†—Dr. L. Dippel points out that confusion has arisen in regard to the test object *Grammatophora marina*, which he formerly described as having 25 striæ per 10 μ (now corrected by further examination to 22). The species, however, which he examined under this name is not the *G. marina* of W. Smith but of Kützing, and he has satisfied himself that the latter is identical with the *G. oceanica* of Ehrbg.

It is therefore *G. oceanica* Ehrbg. to which the earlier descriptions must be considered to apply, the name *G. marina* being reserved for the more coarsely marked species of W. Smith, which has only 15 to 16 striæ per 10 μ, as against the 22 striæ of the former.

There is also a very common confusion in the case of the rare *G. subtilissima* (Bailey?), equally as difficult for a test object as *Frustulia saxonica*. The form supplied to most microscopists is *G. macilenta* W. Sm., which in place of 34 to 36 striæ per 10 μ has only 25–28.

Depth at which Marine Diatoms can exist.‡—Count Castracane adduces reasons, founded on physical and biological considerations, for believing that the light of the sun may penetrate, in a very rarefied condition, to greater depths in the sea than has generally been supposed. The convex surface of the ocean enables it to be regarded as an enormous lens which collects the solar rays, and condenses them more or less in proportion to the convexity of the surface and to the depth. Within the bodies of echini obtained in the 'Challenger' expedition from latitude 41° 13′ N. and longitude 65° 45′ W., at a depth of 1345 fathoms, or 2400 metres, the

* Ann. and Mag. Nat. Hist., xiv. (1884) p. 211.

† Zeitschr. f. Wiss. Mikr., i. (1884) pp. 25–8.

‡ Castracane, Conte Ab. F., 'Profondità cui giunge la vita delle Diatomee nel mare,' 4to, Roma, 1884, 9 pp.

Count found the frustules of diatoms belonging to a number of distinct species and genera, the dominant form being a beautiful *Thalassiosira*, probably *T. Nordenskiöldii* Cleve.

Diatoms of Franz-Josef's Land.*—A. Grunow has had the opportunity of examining a number of diatoms from Franz-Josef's Land, as well as from an ice-block west of Matotschkin-Scharr. They differ from the diatoms at present known from arctic regions, and a number of new species are described. The fresh-water forms are very different from those obtained from deep soil, and much more closely resemble known arctic forms.

Structure of Diatoms from Jutland "Cement-stone."†—W. Prinz, whose previous researches on this subject we have recorded, has, in conjunction with Dr. E. Van Ermengem, undertaken a more elaborate investigation, principally on *Coscinodiscus Oculus Iridis* and *Trinacria regina* (and allied forms from the London clay), making sections by the grinding method previously described. The details and results are embodied in an exhaustive paper, which will be read with great appreciation by all who are interested in the subject. The plates are necessary to properly follow the paper, and these cannot unfortunately be reproduced here.

The short result of the authors' investigations is that not only do the valves of the diatoms examined consist of two laminæ, in the outer of which are hexagonal or circular areolæ, but that the exterior lamina is wholly made up (in the diatoms with hexagonal markings) of the honeycomb structure, entirely open at the top of the alveoli, and that the interior lamina only partially closes these openings, being itself perforated by circular holes at the bottom of each of the hexagons, which holes are bounded by a wall like a section of tube, which projects a little way through the lamina both outwardly and inwardly.

Prof. A. Grunow, *ante*, p. 436, stated his opinion to be that the perforations (which he agreed were proved by the authors to exist in the diatoms from Jutland cement-stone and London clay) were due to the fact that the diatoms had begun to undergo dissolution, the delicate closing membranes of the alveoli disappearing first of all. The authors consider ‡ that this dissolution is disproved by the fact of the preservation (in the cement-stone) of the delicate markings of *Janischia* and the existence of young incompletely silicified valves of *Coscinodiscus*, whilst the diatoms from London clay were covered with pyrites soon after death and before dissolution could have set in.

Dr. L. Errera, in a subsequent discussion,§ raised the question whether, notwithstanding the absence of siliceous membranes covering the perforations (which, however, he did not consider disproved), there might not exist in the living diatom a cellulose membrane

* Denkschr. K. K. Akad. Wiss. Wien, xlviii. (1884). See Bot. Centralbl., xix. (1884) p. 65.

† Ann. Soc. Belg. Micr.—Mém., viii. (1883) pp. 7–74 (4 pls. and 6 figs.).

‡ Bull. Soc. Belg. Micr., x. (1884) pp. 79–82.

§ Ibid., pp. 82–6.

which fulfilled that office. To this Dr. Van Ermengem replied that he "did not at all refuse to admit the existence of organic membranes covering the perforations."

Dr. J. D. Cox, in a criticism * of MM. Prinz and Van Ermengem's paper, considers that their conclusions are "so decisively and explicitly contradicted by the examination of these valves by other means, as to increase rather than diminish our doubts of the value of sections prepared as these have been. The difference is so radical, and so easy to test, that it challenges at once the attention of all who are accustomed to the use of the Microscope.

In the first of the plates which illustrate the paper is a figure of the interior plate of *Coscinodiscus* showing the 'eye-spots.' These are, by measurement, more than half the diameter of the hexagons. In *Triceratium favus* the hexagons are usually four or five to the thousandth of an inch, and the 'eye-spot' or perforation should, therefore, have a diameter of at least ·0001 in. But an amplification of only a hundred diameters would make this ·01 in., and it should, therefore, be easily seen with any good 2/3 objective. As a matter of fact, the 'eye-spots' in the separated inner plate of *Coscinodiscus Oculus Iridis* are so easily seen with a 4/10 objective and a 2-in. ocular, that I am in the habit of using this glass on the double nose-piece as a 'finder' when studying that shell in the large variety found in the Nottingham and Calvert County deposits. Therefore, in an opaque preparation of this shell, or of *Triceratium favus*, since we are able not only to get an amplification of 400 or 500 diameters by the use of high oculars with the glasses named, but by using a 1/4-in. with long working distance may considerably increase the magnifying power, the supposed holes in such shells are far within the limit of common observation by reflected light, and should easily be seen in such slides as Möller's opaque Cuxhaven diatoms which I have already referred to. The truth is, however, that with trifling care in the manipulation of the light, the continuous surface of the inner lamina of *T. favus* may be seen with a clearness which defies all scepticism, and if the glass is a good one, there need be no great difficulty in seeing upon its surface the finer system of dots which is independent of the hexagonal marking, as in the case of *Eupodiscus argus* also. The outer lamina will also be found continuous. There is no room for illusion in this matter. Broken shells are easily found, and some with holes broken in them, and the difference between a plane surface and a solution of continuity is too plain to be doubted. . . . Whether the inner or the outer plate of the valve is examined, the closing of the hexagons by a film is as apparent as in examining with the naked eye a real honeycomb which the bees have capped with wax."

Dr. Cox then describes a confirmatory experiment in which use was made of reflected and transmitted light at the same time. The object was a *Coscinodiscus* "having one of the laminæ in part broken away. It fortunately turned out, also, to be with the convex side up, and enabled me to make what I must regard as an *experimentum crucis*.

* Amer. Mon. Micr. Journ., v. (1884) pp. 66–9.

Its broken surface was peculiarly adapted to bring out the valuable qualities of the vertical illuminator. I first focused on the lower lamina, where the upper was entirely removed from it. This was not quite in contact with the cover-glass, and consequently could not be seen so easily as it otherwise would have been. The refraction of the light made it appear black (as a very thin transparent film on a black background), but the hexagonal outlines where the hexagonal walls were broken away, and the central circular areolæ were still to be seen with careful looking. I then turned to the thicker part of the shell, and here came an unlooked-for surprise. I immediately saw that there were two classes of appearances to be examined. 1st. In small patches over the surface from which the upper lamina had been removed the hexagonal walls stood up here and there like islands. These walls were evidently thickened and incrusted with a white substance apparently more porous than the silex, and this incrustation took the form of nodules at the angles of the hexagons, whilst it partly filled the hexagonal cell at the bottom, giving it a hemispherical or cup-like form. 2nd. Beyond the general line marking the fracture and removal of the upper lamina, and where it was still in place, the surface was smooth and in all respects of the same appearance as the lower surface seen on the first specimen. This I repeated and re-examined till I felt sure of my observations, and that there was no illusion about it. Three classes of appearances stood there as opaque objects, too clear for question: 1st, the black, lower lamina with faint hexagonal and circular markings; 2nd, the island-like portions of the hexagonal cells without the upper film, and incrusted with the white substance; and 3rd, the upper lamina surface, smooth and grey, with its darker hexagonal tracing and circles within.

But it occurred to me to add another test. Whilst the surface was still illuminated by the vertical illuminator I threw a beam of light through the achromatic condenser from the mirror below, and now had what seemed demonstrative evidence, making assurance doubly sure. The lower film was plainly seen, very thin, with shallow circular areolation, the hexagonal lines being almost invisible; the patches of cell-structure stood out vividly, less changed than the rest; but the unbroken part of the structure with both laminæ in place, made transparent by the strong, transmitted, bluish light (the condenser had a blue moderator), showed the internal structure exactly as in the island patches, whilst the fainter red beam of light from the vertical illuminator still marked the gleam of the upper surface by reflection, and the whole structure stood revealed. By turning on and off the transmitted light from the mirror the surface view or the internal structure could be seen in turn, and the fascinating experiment was repeated again and again."

As to MM. Prinz and Van Ermengem's statement that the centre of the "eye-spot," viewed by transmitted light, never shows any film, it is true that along a broken margin of a separated inner lamina of *Coscinodiscus* the eye-spot is usually found empty; but this, Dr. Cox says, is not always so, and in the unbroken portions of such a plate

proper attention to the correction of the objective will enable us to detect it in the robust shells found in the Nottingham earth.

"In the Nottingham slides all the parts of the gigantic disks are increased in size and thickness, and upon examining the interior plate we find within the hexagonal tracing: 1st, a narrow circle so thin as to be scarce distinguishable in colour from the empty field; 2nd, another narrow ring of pinkish colour, evidently thicker than the last; 3rd, another nearly colourless ring; and lastly, a small central part of appreciably pink tint. Nearly every broken valve will give some examples of the inner lamina projecting beyond the outer, and a patient examination will soon find examples in which the fracture, passing through the eye-spot so as to break off only an outer segment of, say, one-third its area, leaves the inmost spot, the pink 'pupil' of the eye, intact. I have verified this so often as to be able to assert it categorically. . . . As to the upper film, the same preparations give abundant evidence of its existence."

J. Deby also,* while not disputing that what the authors describe and figure did actually exist in their sections, nevertheless considers that their deductions are entirely erroneous, which has arisen in consequence of their having studied not living but fossil forms, which have lost not only the purely membranous parts but also a certain thickness of the siliceous layer. The dissolution of the silex of diatoms takes place with great facility, as he shows by an experience which occurred to himself, where some *Epithemia* in a vessel of brackish water with *Synedra* were found at the end of two months to have been entirely dissolved, doubtless furnishing the *Synedra* with the silex which they required for the formation of their valves. Mr. Deby has numbers of diatoms belonging to genera which the authors describe as having perforations, which undoubtedly have septa which close at each end the supposed orifices.

Structure of the Diatom-Shell.†—Dr. J. D. Cox gives the results of a series of repeatedly verified observations on this subject, using both transmitted and reflected light. With the former he preferred balsam slides illuminated by a narrow central pencil, and for reflected light the vertical illuminator was found invaluable. The objectives were of the largest aperture.

Triceratium favus he finds is formed of two laminæ connected by an hexagonal network, of which the areolæ are about as deep as the diameter of the hexagons. The inner of these laminæ is finely dotted with lines of punctæ radiant from the centre of the triangle, the outer lamina being very thin over the centre of each hexagon, to which it is firmly connected by the walls of the areolæ, which are thickened so as to give a hemispherical interior form to the upper end of each.

Eupodiscus argus may be considered, typically, as having a subhexagonal arrangement of areolæ in the outer lamina of the valve, the walls of these areolæ being extraordinarily thickened outwardly, making a rough honeycombed surface. The inner lamina has its

* Journ. de Microgr., viii. (1884) pp. 228–30.

† Amer. Mon. Micr. Journ., v. (1884) pp. 45–9, 66–9, 85–9, 104–9.

independent system of very fine circular dots in radiating lines, and some of these are seen at the bottom of the bright areolæ when the diatom is examined by transmitted light.

Coscinodiscus Oculus-Iridis has been fully dealt with *supra*, p. 941, in Dr. Cox's criticism of MM. Prinz and Van Ermengem's paper.

Leaving the bolder marked forms, in regard to which the existence of areolæ in the valves is so plainly shown by the lines of fracture that there has been little or no dispute about it for some years, Dr. Cox takes up the species and varieties which have much finer markings, and with which the difficulty begins. His remarks will be considered of such interest that we transcribe them in full.

"The most satisfactory method of examination will be found in a progressive study of specimens from each of the more important groups and families, beginning with those having the larger features and passing on to the more delicate. We shall first notice that in the great variation in size which occurs in all species of diatoms we have presented to us examples with a considerable range of diminishing areolæ also. In different individuals of the same size there is also often found much difference in fineness of areolation. The gigantic forms of *Coscinodiscus Oculus-Iridis* found in the Maryland deposits become as small as *C. radiatus*, and the latter is often found in recent marine gatherings side by side with *C. subtilis*, and of no greater size.

We are able, therefore, to follow the diminution of undoubted hexagonal areolæ from the greatest of these specimens, where the valves measure ·016 in. in diameter, till they are scarcely one-eighth as large. Then taking up *C. subtilis* with its hexagons in the larger valves as clearly marked in outline, we find another diminishing series, in which the sharpest scrutiny still leaves us in doubt when we pass from the hexagonal form to that of round punctæ. In this progression we find that the areolæ continue to be the weak places in the shell, the fracture following them in the smaller as in the larger examples. Examined by aid of the vertical illuminator, the surfaces of the valve continue to show the characteristic reticulation and 'eye-spots' as long as we can trace distinct form at all. As the hexagons become smaller we see by transmitted light that they show more colour when the tube is lowered a little, and they are thus brought a little within the focus. In the smallest of these in which we can clearly define the hexagonal outline, the spot becomes quite deeply red. If we next select a valve in which the dots are a little more distant from each other and evidently round (the scheme of marking and the marginal spines being the same as in the larger specimens), we shall find the same conduct with regard to colour when the objective is lowered or raised; that the fracture indubitably follows the line of the dots, and that under the vertical illuminator the smaller dry specimen is not distinguishable from the larger except in the roundness of the areolæ.

Pass now from *C. subtilis*, as we find it along our own coast in gatherings shown in Peticolas's slides from Jacksonville or Fernandina, Fla., to the *Odontodiscus subtilis* of Möller's type-plate or his slides of

gatherings from Wedel marshes, or those of Holland. We have Prof. H. L. Smith's authority for regarding this diatom as identical with *C. subtilis*, and it is, at farthest remove, only a variety of that species. No distinctly hexagonal areolation is seen here, but the punctæ are round, though often so closely set as to lead the eye very persuasively to the illusion of taking them for hexagons. Remembering Nachet's figure demonstrating the liability to mistake on this point, and using to the full the advantage our widest angled glasses have in seizing upon the surface, we shall soon satisfy ourselves that we have round areolæ in a shell of silex showing a pinkish tint. The light within the areola, when the outline is in sharp definition, is of the general pale greenish colour of the field. Depress the tube, and the dots become red spherules; decentre the light from the condenser a little, and they stand out like little balls. Among these valves I have found very numerous examples in which the fracture evidently follows the line of the areolæ. In one specimen a segment had been broken out, one side of it bounded by a regular radial line from the centre of the shell to the circumference. In it the next row of areolæ was plainly separated from the broken part by a line of silex of appreciable width, on the outer edge of which the little irregularities and indentations of the fracture showed where the divisions between the adjacent dots had been. In both the American and the European diatoms I have also occasionally found the two laminæ of the shells of this species separated partly or wholly, as has been noted in the larger species of *Coscinodiscus*, and in such cases the fracture of the inner lamina through the 'eye-spot' is even more demonstrably apparent than in the perfect shell.

The evidence from fracture of the valve and from the general appearance under the vertical illuminator, therefore, justifies the conclusion that the truest view of this diatom by transmitted light is that which we have when the objective is so adjusted that the punctæ appear to be sharply drawn circles in a film of pale pink colour, the circles themselves having a greenish-white light. We may consequently reject the red spherules in this case as the product of diffraction and interference of light. Another bit of experimental evidence on the subject is found in the way in which, on a slight motion of the mirror, the light will flash along behind a diatom, lighting up the areolæ as it passes, and making the comparative darkness of the thicker part of the shell apparent in a telling way. Dr. Greville refers to this in his description of *Aulacodiscus orientalis*,* as making it very evident that the areolæ in the clathrate framework of that beautiful diatom are really thin, window-like spaces, through which the light flashes. The effect is not easily described in words, but it will be recognized by all who have had much experience in studying diatoms under the Microscope.

Another species of diatoms will aid us to carry our induction a little further. In either of the gatherings I have mentioned we may readily find specimens of *Podosira maculata* (*Hyalodiscus stelliger* Bailey), and these will be found of very varying degrees of fineness

* Trans. Micr. Soc. Lond., xii. (1864) p. 12.

in the marking. In the European slides I have generally found them coarser than in gatherings from warmer seas, but they differ a good deal in the same place. The shell is made up of segments radiating from the large granulated umbilicus, and these segments are marked as if cut from sheets of perforated silex, and bent into place on the convex surface of the valve, the edges of the segments often showing lines of apiculi obscuring the suture. In the coarser specimens the areolæ are but little more difficult to define than in *Odont. subtilis*, and in broken ones the fracture may be unmistakably traced through the punctæ. The colour test shows also the same appearances as in the species last described. From this we may follow the increasing fineness of the marking till the dots run together into a diagonal striation rivalling the *Pleurosigmas*, and approaching (though with a considerable interval) that of *Hyalodiscus subtilis*.

As far as we can succeed in defining small areas and minute irregularities of fractured edges, we find the hexagons diminishing to dots and these to still finer punctæ, but they continue to have all the characteristics of an arrangement of areolæ between two laminæ. It is fair to conclude that in those specimens of *Podosira maculata* in which we cannot define the areolæ, they nevertheless exist, and we might add that it is at least probable that the same structure would be found in *Hyalodiscus subtilis* if our glasses were more powerful. I intend to continue for the moment, however, within the region of observation, and to postpone drawing conclusions till we have examined a greater number of species.

The *Actinocyclus*, in its different varieties, is a very interesting genus to study in connection with the preceding series. It is found with disks of less than ·001 in. in diameter, and running up to the splendid proportions of *A. Ralfsii*, measuring sometimes over ·008 in. In some of the smaller species the dots are comparatively large, and the disk will be found subdivided by six or more radial lines of areolæ, each line containing only six or eight of the large dots. In the larger kinds the rays are often fifty or more, with as many areolæ to the radial line. The segments are filled, of course, with similar areolæ, arranged upon a series of parallel lines. I think I may say that of all the species and varieties of this disk which I have examined, there is none of which I have not found examples of separated laminæ, showing inner and outer plates as in *Coscinodiscus*, none in which the line of fracture does not prove the dots in both plates to be the weak places. Some of the smaller disks with large areolæ are found in gatherings from the Samoa Islands and other places in the Indian Ocean. Möller's slides from the Baltic at Kiel give a large range of sizes and conditions. A preparation of *A. fuscus* (*Cos. fuscus* Norman) from Yarra Yarra, Australia, made by Wheeler, shows an unusual number of separated laminæ, an examination of which will confirm my assertion. The fossil earths of Nottingham and Calvert Co., Maryland, are full of *Actinocyclus*, and the deposits of Santa Monica and San Luis Obispo, on the Pacific coast, are rich in various forms of the same genus, with great range in the size of the punctæ.

There is a tendency in most of the species to accumulate silex upon the spaces between the areolæ, giving a roughened and irregularly granulated appearance to the outer surface of the disk. This condition also interferes with a satisfactory examination of the 'dots' by causing irregular refraction, &c. For this reason we need to select smooth and evenly marked specimens for one part of the investigation, though for another the roughened examples are most instructive. We find this thickened coating broken away in different degrees; sometimes leaving the shell smooth but perfect; sometimes taking with it the outer lamina, and leaving only the inner with its delicate punctation. The fact that the thickening is upon the interspaces between dots is additional evidence that the latter are areolæ, since they allow the light to pass when the thickened walls around them make a semi-opaque outline approximating the character of the shell in *Eupodiscus argus*. But among these roughened specimens I have more frequently found the separate inner lamina, and this when once caught by the glass, is always the most convincing proof of the scheme of marking of the valve; for the film is so homogeneous and even, and the dots upon it are diminished to so fine and regular punctæ that the eye is never dazzled, confused, or misled in following its delicate pattern.

The examination of the several species last referred to, under the vertical illuminator with higher powers, and as opaque objects with the 1/4 in. objective, is strongly confirmatory of the interpretation I have given. Reflected light may be made to flash from the surface of all the finer examples of *C. subtilis* as well as from *Actinocyclus* and *Podosira*, so as to show a glassy smoothness, with a play of iridescence in the thinnest specimens. This is true of both the convex and concave surfaces of the valves. No trace of projecting spherules can be seen in such an examination, though the dots of the shells are of such appreciable magnitude that they would be easily visible as protuberances if they were solid spherules. Indeed, with the vertical illuminator and a high power, siliceous fragments of broken sand-grains may often be seen lying upon the surface of these shells, very much smaller than the areolæ, and demonstrating by the ease with which they are seen, that if the dots approached hemispheres in form they also would be perfectly apparent. This, then, is another strong proof that these areolæ are contained between smooth and parallel laminæ.

If, finally, still using the vertical illuminator and a high power, we review the series of valves beginning with the boldest forms of *Triceratium* and *Coscinodiscus* and ending with the finest *Actinocyclus* and *Podosira*, we find certain appearances consistent throughout the whole range of examination. The areolæ, when the surface is carefully brought into focus and the cover correction accurately adjusted, are always an opaque white or grey, whilst the surrounding wall or solid part is darker, becoming even black when close to a dark background. The comparison which I have already made to ice upon a pond, when part of it is solid and clear and part of it porous, very aptly describes this appearance. There is no break in the series. From coarsest to finest the only change is that the areolæ grow smaller

in fact, and generally smaller also in comparison with the solid parts of the shell; but the light is reflected from the surface in the same way, and the experiment ends with a conviction that the differing methods of examination all lead to the same conclusion.

In examining diatoms as opaque objects with the middle and low powers, the appearances vary more than they do with the vertical illuminator, because, as the light is necessarily oblique, its variations of direction produce changes of appearance. Parts which look dead-white with the vertical light may appear dark, and the thicker portions of a shell also change colour; but the changes of manipulation of the mirror give so many variable experiments as to end in strong confirmation of the results reached by the other means. In opaque mounts the thinness of the shell is shown better than in any other form of preparation. From the dense *Eupodiscus argus* we find every degree of diminishing thickness till we come to an *Actinocyclus* lying upon the black slide, its flat disk as black as the background itself, except when the tiny white spots of the areolæ pick out the pattern of its marking, or the projecting ring of the valve marks its circumference. So a *Podosira* or *Cyclotella* will be seen, the merest soap-bubble with its play of colours and its manifest tenuity, speaking plainly of the extreme delicacy of the film of silex.

We will pass over the irregular disk forms for the present, and next consider some of the *Naviculæ*.

In studying the *Naviculæ* we begin with the large *Pinnularia*, where the size of the valves and the simplicity of the marking make easy the application of the criteria we have already established. Using transmitted light, the raphe is found to show the colour of the general background, whilst the smooth longitudinal portion of the valve next it is tinted with the pink colour which indicates thickening of the silex. The central nodule shows this in a higher degree, with lenticular effects. The costæ are pink in tint also, and in large specimens of *P. major* the interspaces between the ribs are often divided into what appear to be two large oval depressions, of which that next the mid-rib is the shallower, as is shown by its excess of colour over the outer one. The central nodule often extends considerably beyond the inner end of the median line, which is a little enlarged, and seems to terminate in a circular dot, which, by its bright light and freedom from colour, should be a depression reaching nearly or quite through the nodule. In a specimen of *P. alpina* from a Scotch gathering I have found a valve turned partly on one side, so as to give an obliquely transverse view through the valve, and in this the enlargement of the median line is plainly seen to extend like a tube through the thick prolongation of the central nodule. It is not uncommon to find broken valves of *Pinnularia* in which the costæ project boldly beyond the interspaces of which the thin film has been partly broken away. I have noticed a specimen of *P. divergens* in which the thin film has been almost wholly removed by some accidental grinding process and the costæ stand out along each side like the teeth of a comb. Prof. H. L. Smith has given me another similar example of *P. major*. The raphe appears to be like a channel having a very thin film at the bottom,

which is part of the firm silex on one side and laps under the other side in a way similar to the 'rabbit' in joinery.

Of the dotted *Naviculæ*, *N. lyra* may fairly be taken as the type. Its beautiful regularity of form, and the clearness and boldness of its marking make it a very profitable subject for careful examination. It is easy to get somewhat varied appearances by different uses of the light and changes of focus of the objective, but if we use the narrow central pencil of light and care in focusing, its characteristics will be found uniform and unmistakable. Its lyrate hyaline figure in the middle of the valve takes the pink tint. The dots are found to be between costæ which are fully as wide as the dotted interspace, and these have the same colour as the lyrate figure. Find a broken shell and focus carefully upon the broken margin. Oftentimes the costæ will be found to project beyond the interspace, showing its greater strength, and confirming the evidence to this effect which is found in its deeper colour. When the focusing gives us the costæ as well-defined ribs of even width, and a broken edge is also most sharply defined, the dotted interspace will approximate to a ladder-like appearance, the dots having a sub-rectangular form, and being separated from each other by septa considerably narrower than the costæ between which they lie. The term 'sub-rectangular' which I have used must not be taken too literally, for the figure of the dots is that of a circle somewhat flattened on four sides. Assuming that the median line is a groove in the valve, and focusing upon it so that the light coming through it shall correspond nearly to the general field, it will then be found that the dots nearest this line and most perfectly in the same plane show the same colour, an item of evidence that they, too, are thin places in the shell. But the line of fracture gives still stronger proof. I have before me a broken valve of *N. lyra*, in which a segment is entirely gone, bounded by the median line for, say, half the distance from the end of the shell to the central nodule. Then the broken margin runs irregularly off to the rim of the shell. On the other side a wide crack extends diagonally from the median line a short distance, then runs straight out to the rim. This crack (examined with a 1/15 objective) zigzags through the dots in the first part of its course, and in the straight part runs indisputably through the dots and between the straight costæ. The broken edge of the other side of the shell shows with equal clearness that the fracture is through the dots. I have many such cases noted, with great varieties of fracture but all indicating the same fact in regard to structure, viz. that the dots are the thin and weak places in the valve.

Another point to be noted is that whilst the radiant costæ of *N. lyra* are straight, making also straight transverse striation, when viewed with a low power, the longitudinal septa between the dots are not regularly continuous; consequently, when light is thrown transversely across the shell a low power shows longitudinal striæ, but wavy instead of straight. This is also the case with the striation of *N. firma*, *N. cuspidata*, *N. rhomboides*, and *Frustulia saxonica* when examined with high powers, and with the *Nitzschias* of the form of *N. scalaris*, *N. linearis*, &c., of which the coarser specimens show

distinct lines of punctæ between parallel costæ. It is characteristic, too, of the difference between the transverse and longitudinal striæ of *Surirella gemma*. It is certainly natural to conclude that the similar phenomena are due to similar structure.

In *Naviculæ* having strongly radiant costæ, some, like *N. peregrina*, show a similar dotted structure between the ribs, and in these cases the lines of separation between the dots are also much finer and less prominent than the costæ. In another class of *Naviculæ*, of which *N. sculpta* Ehr. is an example, the dots, whilst arranged in lines, do not have thickened costæ between the rows, but are like separate, sometimes elongated, punctæ in a shell of even thickness. In these, however, as in *N. lyra*, the line of fracture follows the dots, and the hyaline parts of the valve show the pink colour, so that both lines of proof still combine to show the dots to be the weak and thin places in the valve. A beautiful example of the latter sort is *Mastogloia angulata* Grun., which is not uncommon in Long Island Sound, and is found along the whole Atlantic coast. The shell is broad ovate, somewhat cuspidate, of smooth, even thickness, and the punctæ are arranged in oblique rows. With a medium power the effect is that of a delicate cross-hatching, much like that of *P. angulatum*. With a high power the dots are well separated, and, except as to arrangement, their appearance is similar to those of *N. sculpta*. As in the disk forms the diminishing size of the areolæ brought us gradually very near to the fine lines of *Hyalodiscus subtilis*, so among the *Naviculæ* we make a similar approximation to the delicate marking of the *Pleurosigmas*.

The use of the vertical illuminator upon these diatoms is hardly less decisive in support of the conclusions I have drawn than in the case of the *Coscinodisci*. A smooth surface, dotted with tiny bubbles, is the characteristic appearance of the shell, and these bubbles, in the larger kinds, cannot be distinguished from those which we have found in the disk forms, beginning with examples from the Nottingham earth, where the hexagons and round areolæ were found side by side upon the same valve. We may even take a step in advance. In Peticolas's slides of Richmond and Petersburg earths there are numerous examples of a coarse form of *P. angulatum* var. *virginicum*, in which the marking in the middle of the valve is coarser than at the extremities. In dry specimens of this shell a high power used with the vertical illuminator will separate the dots sufficiently to show a surface hardly to be distinguished from that of *Mastogloia angulata*, which I have noticed above. It is a smooth film in which the minute bubble-like dots have the same character, and differ only in size from those in *Actinocyclus*, or in the coarser smooth *Naviculæ*. In some broken specimens, also, the line of fracture could be traced through the dots.

In *Stauroneis pulchella* the areolæ are much longer in proportion to their width, and are contracted at the ends so as to take the 'oat-shaped' appearance by which they are commonly known. There is here found a difference in the appearance of the concave and convex sides of the valve, the former presenting the areolæ more

nearly as rectangles, and the latter giving more of the spindle shape. This is analogous to the difference noted in other genera, the outer view of hexagonal markings being usually nearly circular, whilst the inner shows the angles more clearly. In *Epithemia turgida*, as found in Möller's preparation from the Södertelge mud, the framework of the shell is a nearly rectangular lattice, the areolæ showing all the peculiarities of light which have been described in *Navicula lyra*, and the fracture often shows the ends of the framework sticking plainly out beyond the sides of the adjacent dots. The same may be seen in the elongated areolæ of *Amphora ovalis* of the larger varieties. In *Cocconeis splendidum* the hexagons are as distinctly formed as in *Coscinodiscus*, and in *C. scutellum* the areolation varies from coarse to fine with the diminishing size of the valves, giving a series analogous to those which are found in *C. subtilis*, and one in which the fracture is as plainly through the dots, whilst the evidence of relative thickness or thinness of the silex from the colour is as we have found it in other cases.

But to complete the list of species in which I have found the tests of fracture and of colour supporting the theory of areolation of the diatom shell, and contradicting that of solid spherules, would be too much like making a catalogue of all in which the details are large enough to give a well-defined outline to a broken edge. In the progressive series of fine markings we sooner or later reach the point where the thinness of a film causes it to be lost in the general background of the field, or where the prismatic edge of a fracture makes diffraction enough to fringe it with lines of colour or of apparent shadow, which make every cautious observer hesitate to affirm whether the boundary is in or beyond one of the striæ. The fringes move with the slightest motion of the fine adjustment, and the interpretation of what we see is more or less modified by the preconceived theories of the observer. I have intended to draw my examples of facts from specimens found clearly within this limit of doubtful discrimination. I am myself satisfied that in the coarser specimens of different species of *Pleurosigma* careful illumination and accurate adjustment of good lenses show the same characteristics of structure at broken edges of shells which I have described in the larger and bolder forms. In regard to this, however, I admit there is room for dispute. In the matter of the colour test, on the other hand, the evidence seems to me clear. If the objective is well adjusted, and the median line is brought into focus, so that it appears a greenish white line of nearly the same tint as the general field, the dots which are near enough to it to be in the same plane are found to have the same colour. In *P. formosum*, *P. balticum*, *P. attenuatum*, and the varieties closely allied to each, the reticulation seems to be thickened upon the outer edges of the lines, so as to leave a cup-like depression in the interstices, which is yet consistent with double laminæ below. We have seen that in *Eupodiscus* this thickening becomes so great as to be quite opaque. In *Aulacodiscus oregonianus*, and in *A. orientalis*, it is sometimes found thick enough to give a decidedly dark colour to the reticulation of the surface. In media of higher refractive

index than balsam this becomes still more noticeable. In the *Pleurosigmas* I have named, I think a similar thickening of the lines (much more delicate, but real) has taken place, and that this gives the strong cross-hatching which marks them. In the varieties more closely allied to *P. angulatum* the shell is smoother, and in some of these the surface, with high magnification, and both by transmitted light and under the vertical illuminator, is found to resemble very closely that of the distinctly areolated forms which have been described.

In conclusion, I will notice briefly a few of the less regularly marked diatoms, but which still seem to me to corroborate the view of their structure which I have maintained.

In a group of species allied to *Navicula prætexta* Ehr., including *N. Kennedyi*, *N. indica*, *N. clavata*, &c., the regular striæ are confined to narrow bands at the margin and along the median line, the intermediate space being either hyaline or mottled in varying degrees of distinctness. Specimens which have this mottling most distinct exhibit it as a system of rather large but faint dots, arranged in lines continuous with the distinct striæ at the margin, &c., but the dots in these lines are irregularly spaced as to distance. Occasionally an individual is found in which the dots are as sharply defined as in any of the smooth *Naviculæ*, and giving the proof that they are areolæ by fracture and by colour. Arranged in a series, therefore, they show us that the diminishing distinctness of marking is due to the progressive shallowness of the depressions in one of the laminæ of the valve, until from faintest mottling the dots disappear entirely, leaving the interior space smooth and hyaline.

The study of these last assists us in understanding the marking of *Heliopelta*. In this splendid shell we have, first, an outer lamina or film, finely punctate, making the appearance of diagonal cross-hatching upon each of the undulating segments. This film is sometimes found partially separated from the under one, much as the laminæ of *Coscinodiscus* are found. In the Nottingham and Calvert County earths I have found this separation extending over part of a segment of the shell, a whole segment, two or three segments, and in one instance the whole valve. In this last case the separate outer lamina is not distinguishable from the figure given as *Actinoptychus pellucidus* Grun., by Van Heurck, and I cannot doubt that this latter is a separated plate of a similar valve. The separation has included the central hyaline star figure in the shell as well as the dotted part, showing that the laminæ exist here also, notwithstanding the homogeneous transparence of this part of the valve. In the second place, the inner lamina is found to have a different marking in the undulating segments. Those projecting outwardly from the face of the frustule are areolated with a sub-hexagonal areolation, quite distinctly defined. Those which are depressed have usually a much shallower sculpture, of which the normal marking is an hexagonal arrangement of large shallow dots, but these are sometimes enlarged into a system of more distinctly marked equilateral triangles combined, so that the six form a regular hexagon. The difference between

the deeper and shallower areolæ in this case is similar to that which has been described in *Navicula prætexta*, &c., and when they are covered by the lace-like veil of the finely dotted film we have the beautiful and changeable effect which has proved so puzzling to observers. In whole valves of *Heliopelta* the larger areolæ will often be found showing in the central part of the shell where the fine dotting of the upper film does not extend over them, and their character may there be pretty satisfactorily determined, even if the separated laminæ are not detected."

After referring to the similarity of structure in *Halionyx*, and dealing briefly with a few other forms, Dr. Cox concludes with the summary of his results which will be found *supra*, p. 853.

MICROSCOPY.

a. Instruments, Accessories, &c.

Japanese Microscope.—Fig. 145 shows a modern Microscope made in Japan and purchased last year in Tokio. The Japanese workman must have evidently had before him one of the old forms of "conical" Microscope which were current in this country in the last century.

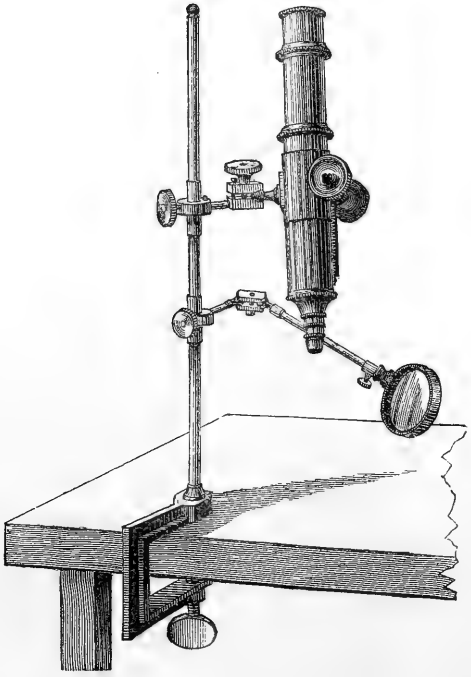
FIG. 145.

A special feature of the Microscope is its exceptional instability, the feet being made of thin and very springy pieces of metal, so that the whole instrument vibrates in every part at the least movement of the table. The four objects are inserted in a metal plate which slides from right to left in grooves in the stage. There is no provision, however, for shifting the plate from back to front, and so obtaining a view of different parts of an object in that direction. The body tube has 2 eye-piece lenses, and a single-lens objective of about 1/2 in. focal length. The metal of which the instrument is made is copper, coated with a black japan, the body tube being covered with leather figured in gilt. The plate immediately below the mirror can be rotated on the box beneath,

carrying with it the whole of the upper part of the instrument, the mirror remaining stationary. We imagine, however, that this movement is the result of defective workmanship, and was not designed as a means of providing oblique illumination.

Schieck's Corneal Microscope.—This (fig. 146) was designed by F. W. Schieck for the examination of the cornea. A steel standard (16 in. long) is secured to the table by a screw clamp. On it slide

FIG. 146.

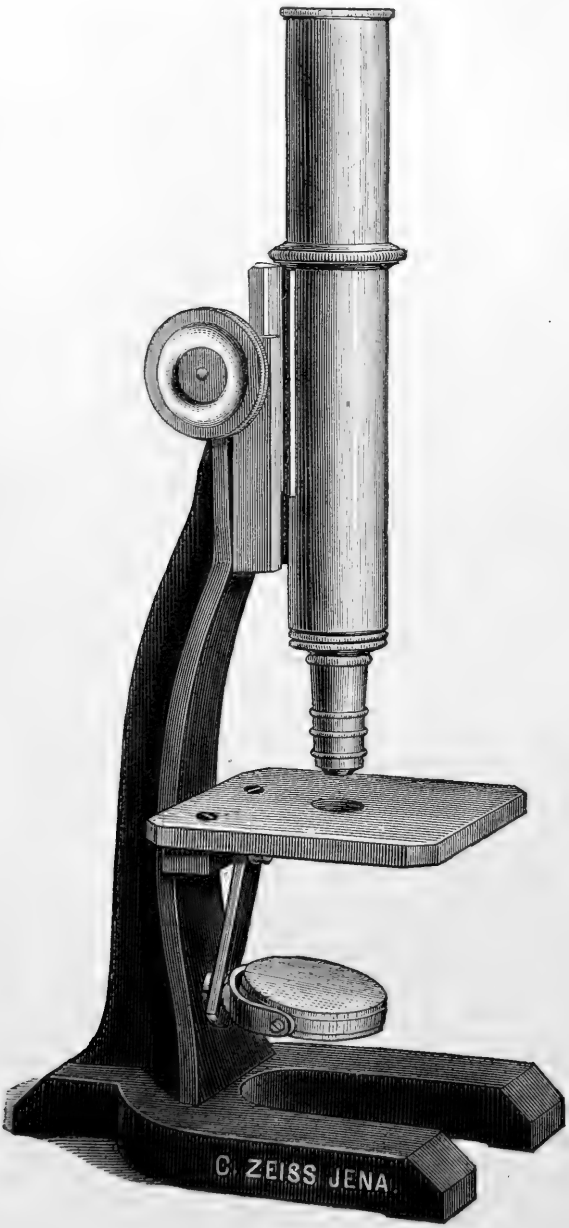


two arms which can be set at any required height by screws. The upper short arm carries the Microscope, which is connected with it by a ball and socket joint and clamp screw, so that great range of motion is obtained. A rack and pinion serves for focusing.

The lower arm carrying the condensing lens consists of two rods connected by a double ball and socket joint. The lens moves on a hinge and also rotates on the rod, a small screw, the point of which works in a groove encircling the end of the rod, preventing it from slipping off. For the lens a mirror having the same movements can be substituted.

Zeiss's No. X. Microscope.—This (fig. 147) is noticeable mainly for the manner in which the upright support is constructed. The limb is of the "Jackson" form, but is continued to the base, to which it is

FIG. 147.



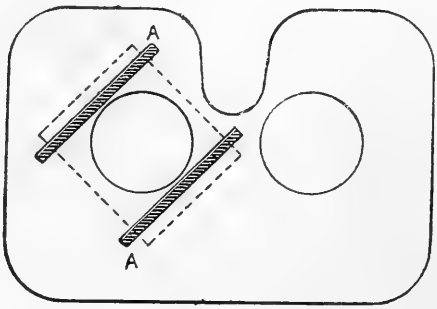
fixed. The stage is attached to the limb. The focusing is by means of rack and pinion only, without fine adjustment. The general design and construction are so simple that the instrument is issued at a very low price indeed.

Wray's Microscope Screen.*—L. Wray, jun., thinks that all who have ever used the Microscope must be painfully aware of the fatigue and distress which prolonged work with it causes to the eyes, and therefore describes a device which he has been trying with this object in view. When the eyes are exposed to a bright light, and one of them is then covered over, the pupil of the uncovered eye at once enlarges, and he believes this action of the iris to be the cause of the distress produced in the use of the Microscope, for the pupil of the working eye is unduly enlarged by the other eye being either shut or shaded by a black screen, consequently more light is admitted to the retina than it can comfortably bear, and the irises of both eyes are in a state of tension, the one tending to contract and the other to expand.

The way in which he counteracts this is by exposing both eyes to an equal light, by attaching to the eye-piece a cardboard screen, which has two holes cut in it, the one to fit on the eye-piece, and the other to allow a thin piece of even-grained white paper being presented before the eye that is not in use.

A back view of the screen is shown in fig. 148, with the paper removed. The two lines A A are intended to represent elastic

Fig. 148.



bands, by which the squares of paper are kept in place, as indicated by the dotted lines, one, two, or more thicknesses being used, according to the brightness of the field and translucency of the paper. The object being to illuminate both eyes equally, it will be found convenient to gum on one thickness of this paper, and to have two or three loose slips to adjust the amount of light.

The plan is one that any one can try for himself; but a more refined method of accomplishing the same thing is to have a ground

* Engl. Mech., xl. (1884) p. 180.

glass screen lighted with a small mirror, and a set of revolving diaphragms to adjust the amount of light.

At first it will seem strange to have a light before the eye not in use, but after a short time this will wear off, and it will then be found that far brighter illumination of the field can be borne when using this device than when closing one eye or employing a black screen.

Abbe's Micro-spectroscope.—This was described at p. 703 of Vol. III. (1880), with an outline diagram of its construction. Its special feature consists, it will be remembered, in the arrangement by which the position of the lines in the spectrum is determined by a direct reading of their wave-lengths on a scale in fractions of μ. The apparatus (half natural size) is shown in fig. 149, and the arrangement for widening the slit in fig. 150.

The tube J containing the prism moves on the excentric pin K so as to turn it away from the eye-piece when required for focusing the object. It is fixed in place by the catch L. The slit is in the

FIG. 149.

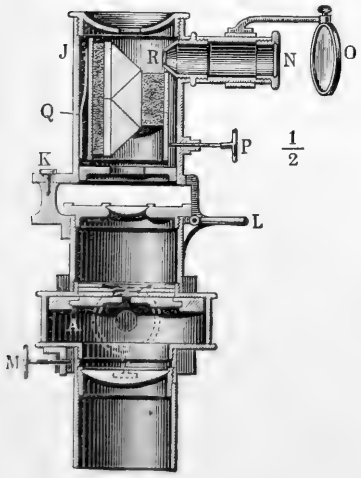
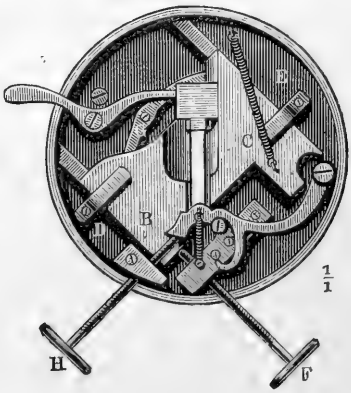


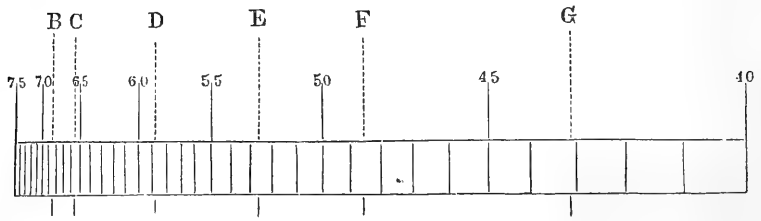
FIG. 150.



drum A, and is made wider or narrower by the action of F, which causes the plates B and C, connected by the lever-arm G and moving between the guides D and E, to approach each other symmetrically. H, on the other hand, regulates the length of the slit. The scale N (fig. 151) is illuminated by the mirror O, and its image is thrown on the spectrum by the objective at R. By the milled head P, which acts against the spring Q, it is set so that the Fraunhofer line D coincides with 0·589 of the scale. The screw M serves to secure the

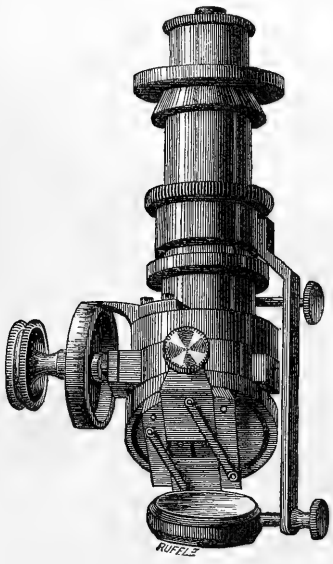
apparatus to the body-tube of the Microscope, into which it is slipped as far as the lower end of the drum A.

Fig. 151.



The comparison prism with its illuminating mirror is not shown, though the latter is indicated in fig. 149 by dotted lines. It is turned away from the slit by the lever-arm shown in fig. 150.

Fig. 152.



Engelmann's Micro-spectral Objective.*—This (fig. 152) was made by Dr. Zeiss for examinations by Prof. T. W. Engelmann's Bacteria-method.

It consists of a plane mirror, a slit, a collimator lens, and a direct-vision prism. The whole apparatus is 77 mm. long, and is applied beneath the stage, ordinary objectives according to the size of the spectrum desired being screwed on at the top to project a spectrum at the plane of the object under examination. Both sides of the slit are moved symmetrically by the screw with divided drum. This screw has two opposite threads on a common axis, so that the centre of the slit never changes its place. The drum gives the width of the slit in hundredths of mm. The smaller milled head moves outer slides to regulate the length of the slit.

In place of the prism a grating can be used, which would give an interference spectrum.

Mayall's "Stepped" Diagonal Rackwork.—Mr. J. Mayall, jun., has suggested the application to the coarse adjustment of a "stepped" diagonal rackwork for increasing the smoothness of the motion.

* See this Journal, ii. (1882) p. 661. Bot. Ztg., xv. (1882) pp. 419-26 (1 fig.). Pflüger's Arch. f. d. gesammt. Physiol., xxvii. (1882) p. 464, xxix. (1883) p. 415.

Fig. 153 shows the arrangement as first applied with three racks, the teeth of each part being set out of line to the extent of one-third their pitch and the spiral pinions being fitted to correspond with the racks. The effect is similar to what would be obtained by pitching the teeth of a single rack three times as finely, but at the same time retaining the strength due to the coarser pitch.

Mr. Mayall subsequently suggested that as the fitting of three

Fig. 153.

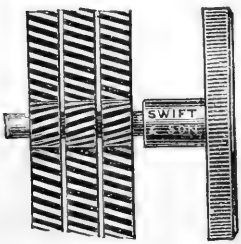
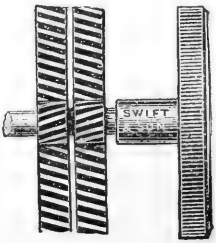


Fig. 154.



pinions on the same axis presented some difficulties of workmanship, these might be considerably reduced by using two racks instead of three, as shown in fig. 154, still retaining a considerable advantage over the ordinary single diagonal rack.

Fasoldt's Nose-piece.—Mr. C. Fasoldt's form of nose-piece (fig. 155) is somewhat similar in principle to that suggested by Mr. Curties.* The Society screw to receive the objective consists of three segments, one of which is on a movable piece which is acted on by a spring lever, a jam-nut enabling the lever always to be set at the most convenient point for working it, say in front of the body-tube. On pressing the lever the objective can be introduced, and if inserted so that the threads correspond, will not require any turning, but otherwise a fraction of a turn may be necessary. "The position of each objective when screwed up is readily found, and can then be marked so that it may always be inserted near this position."† The latter requirement would seem to introduce an element of difficulty, which it is the essential object of such contrivances to eliminate.

Fig. 155.

Spencer's Dust-protector for Objectives.‡—H. R. Spencer & Co. have patented a device to protect the interior and backs of objectives from dust. It consists of a thin piece of plate glass polished, and mounted in a ring screwed into the back of the objective. It is

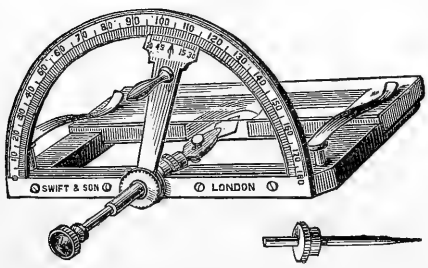
* See this Journal, iii. (1883) p. 572.
† Cf. Micr. Bulletin, i. (1884) pp. 42–3.
‡ Amer. Mon. Micr. Journ., v. (1884) p. 200.

claimed to be "a valuable addition to a lens, while not affecting the corrections or interfering with the performance of the objective in any way. The plan will especially commend itself to all workers who leave their objectives attached to the stands, as dust is sure to find its way to them, even under glass shades."

This device was adopted by the late F. A. Nobert many years since.

Swift and Son's Goniometer Stage.—This instrument (fig. 156) has been constructed by Messrs. Swift and Son for use with their petrological Microscope. It consists essentially of a pair of forceps attached to a pointer moving round a graduated semicircle. It is used as follows to determine the separation of the optic axes in biaxial crystals:—

FIG. 156.



A section of the mineral cleaved or cut perpendicularly to the first median line is placed in the forceps and the apparatus adjusted on the stage of the Microscope, so that the line joining the optic axes is inclined 45 per cent. to the crossed Nicols which are set parallel to the cross wires of the eye-piece, whilst the same line is at right angles to the direction in which the forceps point. The pointer is then turned till the darkest part of one of the "brushes" covers the intersection of the cross wires, when a reading of the scale is made. The pointer is afterwards turned in a contrary direction till the darkest part of the other brush covers the intersection of the cross wires, when a second reading of the scale is made. The difference between the two readings gives the apparent angle in air. The angle in oil or other liquid can be determined in the same way by setting the Microscope horizontally and adapting a small glass cell filled with oil or other liquid, but in this case it is requisite to use an eye-piece provided with a Nicol which rotates so as to allow of the polarizer and analyser being set at 45° to the vertical direction of the forceps.

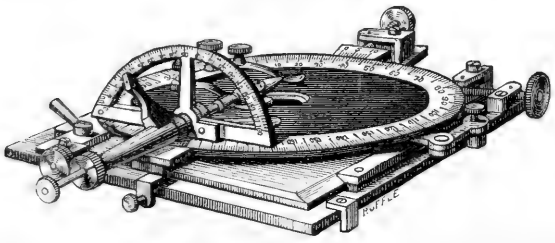
Very small sections of minerals may be attached by wax to the point of the forceps or to a needle fixed in their place.

Hartnack's Goniometer-stage.—The stage shown in fig. 157 has priority of date (by several years) over the preceding.

The base-plate lies on the stage of the Microscope, to which it is clamped by the small screw in the angle-piece below the semicircle, two other similar angle-pieces, but without screws, being fixed to the opposite and one of the remaining sides. On the base-plate are two slides moved by the milled heads at the back and right-hand side of the fig., giving lateral motions in two rectangular directions. The

upper circular plate can be rotated by the hand, or by turning the small handle shown on the left it is fixed, and then can only be rotated slowly by the adjacent tangent screw. The graduated semicircle and forceps are screwed to the upper plate, and can be removed

FIG. 157.

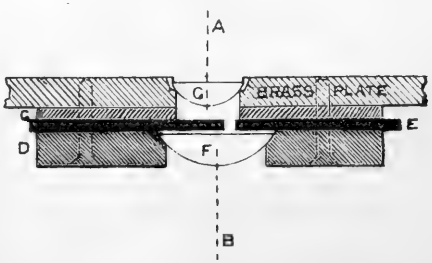


so as to leave the stage free. The movement of the index and forceps jointly is effected by the larger milled head on the axis of the forceps.

Osborne's Diatomescope.—Lord S. G. Osborne has forwarded to us his diatomescope, together with notes from which we have made the following description and diagram.

The apparatus (fig. 158) consists of a rectangular brass plate, 3 in. by $1\frac{3}{4}$ in., in the centre of which is a plano-convex lens G, with its plane face nearly flush with the upper surface of the plate. A thin metal disk C, having a central opening corresponding with the diameter of G, is placed beneath the plate to separate the upper from a second plano-convex lens F, which is mounted slightly out of the centre of the thick metal disk D, so that its axis B is a little at one side of the axis A of the lens G. The upper surface of D is grooved to permit a diaphragm-plate E, having a small square opening of 1/32 in., to traverse between the lenses.

FIG. 158.



The apparatus is placed upon the stage of the Microscope, and the slide is laid flat on the plate, with or without immersion-contact with G, and is held in position by two spring clips. A pencil of light suitably incident on F is refracted through the small opening in E to the curved surface of G, where it is again refracted, emerging from the plane surface more or less obliquely, according to the original incidence and to the position of the diaphragm.

We understand from Lord S. G. Osborne that the device has also been made to fit in an ordinary substage, where it is of course more serviceable than on the stage proper.

Mr. E. M. Nelson * somewhat severely criticizes the instrument. With it used dry, he can just get a dark field with an objective of 0·82 N.A., but the effect is far better with an objective of 0·8 N.A. "Therefore, as far as dark fields are concerned, it does all that is claimed for it. As regards the *quality* of the dark field, it fails, as every other illuminator, which only gives an oblique pencil in one azimuth, must fail. A diatom, to be shown critically on a dark ground, must be illuminated all round; one edge is always blurred when the illumination is from one side only. One will say then, that, if it is not good as a dark-ground illuminator, it must be a first-rate striæ resolver. This, however, is not the case. For an instrument to be a good striæ resolver it must be capable of varying the obliquity of the illuminating pencil. The strongest resolution is always obtained *just before* the field gets dark. Of course I am aware that the obliquity of the illuminating pencil may be varied to a small extent by dodging with the mirror; but that fidgety sort of business cannot be compared with the certain method of a central and focused condenser and a slot cut to a known depth. As mine is mounted, you can neither rotate the beam about the diatom, nor the diatom about the beam."

On this "F. R. M. S." says † that it "is unquestionable that the little device will do good service within the limits prescribed by its aperture. Mr. Nelson should not taboo it for not possessing powers beyond the scope of its designer. He would hardly consider it fair if the 'Nelson' Microscope-lamp were publicly condemned for not being provided with all the luxurious movements of the 'Dallinger' lamp. The construction of an illuminating apparatus of special convenience and efficiency is almost invariably a question of expense. Greater outlay would convert the 'Nelson' lamp into a 'Dallinger.' The 'Nelson' costs some five guineas; and yet is there any feat of microscopical illumination possible with it that could *not* be done with a sixpenny paraffin lamp and brown paper diaphragms in the hands of an expert—say, in the hands of Mr. Nelson himself?"

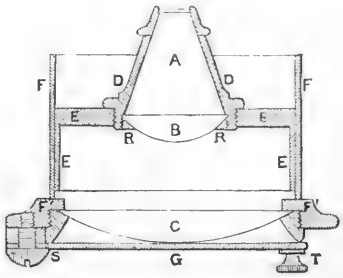
Lord S. G. Osborne replies ‡ to Mr. Nelson's criticism, and "still confidently recommends the instrument to the very many observers who have no substages, not for hypercritical study of diatoms, but as giving most lovely pictures of some of Nature's most beautiful work."

Wallich's Condenser.—Dr. G. C. Wallich has patented an improved condenser intended to obviate the difficulty which has hitherto been experienced in adequately illuminating objects having considerable depth, and more especially when examined in the binocular Microscope and with high-power objectives. It extends the range in depth through which more or less transparent objects may be distinctly seen; and, when used with the binocular, facilitates the production and increase of true stereoscopic effect. The speciality

* Eng. Mech., xl. (1884) p. 157. See also further remarks, p. 242.
† Ibid., p. 199, and see pp. 263-4 (1 fig.).
‡ Ibid., pp. 180–1.

of the improvement consists in the employment of a truncated cone of glass, in combination with one or more lenses capable of being adjusted with respect to one another. The conical surface is highly polished, so as to constitute an internally reflecting surface, the cone having such an angle as to produce total reflection.

Fig. 159.



In fig. 159 A is the cone mounted in a cell D and having a lens B attached to its larger end by transparent cement. C is a second larger lens, and mounted in suitable fittings E and F, by which its distance from B can be adjusted so as to produce various effects. As improved effects may in many instances be produced by preventing the admission of light into the condenser from one or other side of the lens C, a shutter G is added, pivoted at the circumference of the cylindrical fitting F^1 by a screw S, which shutter can be set in any required position by moving the knob T, or by rotating the entire condenser in or by its fittings.

For the purpose of producing various effects of illumination diaphragms are also used furnished with openings of various shapes and sizes, placed either between the lenses B and C, or in front of the smaller polished transmitting end of the catadioptric cone A.

Cells for Minute Organisms.*—In breeding Oribatidæ, Mr. A. D. Michael used glass cells each composed of an ordinary microscopical glass slip 3 × 1 in., having in the centre, fastened by marine glue or Canada balsam, a glass ring made of a transverse slice of glass tubing about 3/4 or 7/8 in. in diameter, the length of the tube, and consequently the depth of the cells, being usually about 3/8 in. The tubing should be of tolerably thin glass, if very thick it is opaque, and leaves little room inside the cell. Over this a thin glass cover, rather larger than the diameter of the tubing, was laid, either a circle or a square; the latter is often handy, as the projecting corners are convenient to take it on or off by, or sometimes a second slide or a broken piece of one is more serviceable. This cover was always quite loose, and simply held on by an ordinary brass-wire microscopical spring-clip; of course the upper edge of the slice of glass tube required to be smooth, so that the cover would lie flat upon it, and not allow the minute animals to escape.

A cell so prepared was carefully cleaned out, and examined under the Microscope, to see that it did not contain Acarina or ova. A small piece of thick white blotting-paper, not large enough to cover the whole bottom of the cell, was then placed in it and damped; a piece

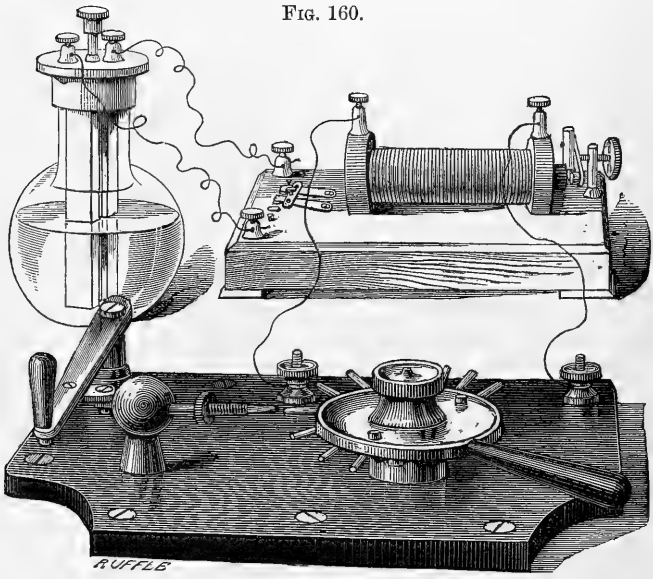
* British Oribatidæ, i. pp. 68–70.

or two of growing moss or fungus was then placed in the cell, having first been carefully examined under the Microscope to see that it also was free from Acarina and ova, and the cell was then ready for use. One or two specimens of the larva, nymph, or species to be observed, were placed in the cells; the cover was put on and fixed with the clip. By carefully attending to the hygrometric condition of the cell, damping the blotting-paper or removing the cover to give air as required, the animals throve well and got quite accustomed to the cells. When it was desired to observe the inmates, which was done at frequent intervals, the clip was removed and the cell transferred to the stage. If low powers were sufficient, the cover did not require to be removed if kept clean and if free from condensed moisture; if, however, higher powers were used it was found that usually the cover could be safely removed.

Mr. Michael found these simple cells answer better than any of the more elaborate apparatus. In particular he tried Mr. Macintyre's ingenious cork cells, but did not find them answer for Oribatidæ. In the first place, many species, being wood-borers, simply ate their way out or into the cork; in the next place, the very minute ones got lost in the interspaces of the cork and never reappeared; in the third place, the cells got dry too easily, and were apt to be too wet or too dry; the former of which was injurious, and the latter always fatal.

Stokes's Spark Apparatus.—Mr. A. W. Stokes has shown at the

Fig. 160.



conversazioni of this Society and of the Quekett Club the sparks of various metals under the Microscope, an exhibition which has proved

of great interest, and has always attracted much attention. The ingenious apparatus which he uses is shown in fig. 160 (drawn from an improved model made by Messrs. Watson and Sons.

The base-plate is of ebonite, and has at one end a small pillar, through which passes an arm carrying a piece of platinum. A similar support at the other end carries a double disk, between the plates of which are inserted the pieces of metal to be experimented on, viz. magnesium, tin, brass, steel, carbon, lead, iron, copper, platinum, and aluminium. The disk can be rotated by an ebonite arm so as to bring each metal successively in line with the platinum. The distance of the latter from the pieces of metal can be increased or reduced by moving the lever-arm with which the platinum holder is connected. A pint bichromate cell in connection with a small induction coil is sufficient to actuate the apparatus. A 1 in., 1/2 in., or 2/3 in. objective shows best. With a higher power than the 1/2 in. the spark is likely to pass to the brass of the objective.

The apparatus is adapted for use with the micro-spectroscope.

Bertrand's Polarizing Prism.*—E. Bertrand proposes a new form of polarizing prism as follows:—"The Nicol prism, the polarizing apparatus most generally employed, is attended with certain disadvantages: (1) the obliquity of the end-faces in relation to the axis of the prism; (2) the length of the prism, which is about four times its breadth; (3) the extent of the field, which is less than 30°; (4) the necessity of employing a very clear and somewhat large piece of Iceland spar, which is becoming more and more scarce and expensive.

Hartnack and Prazmowski † have improved this apparatus; the end-faces of their form of prism being perpendicular to the axis, the prism is shortened, and the field increased to 35°.

In the Nicol prism, and in that of Hartnack and Prazmowski, a luminous ray passing through the spar is divided in two: the ordinary ray undergoes total reflection at the film of Canada balsam or linseed oil, whilst the extraordinary ray is transmitted. By computation the field, within the spar, cannot exceed 26° 33′ 45″; on emerging into air the rays expand and the field attains 35°. It is impossible to exceed this exterior angle by utilizing the extraordinary ray; but if the ordinary ray were utilized, in consequence of its higher refractive index, the field would be increased to 44° 46′ 20″ in air.

To attain this result, I use a prism of flint glass of index 1·658 which I cut through a plane at an angle of 76° 43′ 8″ to the end-faces; the two section-faces thus produced are polished and between them is placed a cleavage plate of spar suitably oriented, the whole cemented together with a substance of refractive index equal to, or greater than 1·658.

A ray of light entering the prism normally cannot traverse the plate of spar without being divided into two rays, which are polarized at right angles. The ordinary ray, whose index is 1·658, will

* Comptes Rendus, xcix. (1884) pp. 538–40.
† See this Journal, iii. (1883) p. 428.

proceed without deviation, but the extraordinary ray, whose index is between 1·483 and 1·658, according to the direction of the ray, will not enter the spar if the angle of incidence is suitably regulated. My prism is devised to fulfil these conditions.

A polarizing prism is thus obtained about equal in length to that of Hartnack and Prazmowski, but the exterior field of view is 44° 46′ 20″. A large piece of spar is not required, a simple cleavage plate suffices; moreover, as the end-faces are of flint glass, they may be cleaned without injury.

This form of construction may be still further improved: the flint-glass prism may be cut in a plane forming an angle of 63° 26′ 15″ with the end-faces, and a cleavage plate of spar inserted between the section-faces as before. This prism is again cut in a plane symmetrical with the former in relation to the axis, and the two parts are cemented together, having between them another cleavage plate of spar placed symmetrically in relation to that in the first section. We thus obtain a polarizing prism half the length of Nicol's, with a field of view of 98° 41′ 30″."

Electric Illumination for Anatomical, Microscopical, and Spectroscopical Work.*—Dr. C. von Voit describes the result of some experiments as to the electric light, conducted by himself and Drs. Kühne, Kupffer, Rüdinger, and Bollinger.

The lamps used were an Edison incandescent lamp, of about 16 candle-power, a Müller, of about 24, and a Maxim of from 36 to 60, respectively.

In every instance the light was sufficient for the finest microscopical observations, and for the highest magnifying powers, free from the well-known disadvantages of other artificial illumination, such as the preponderance of the yellow-rays, and the heat with close approximation. When the light of the Maxim lamp was raised to about 60 candles, so that the M-form of the carbon filament was unrecognizable in consequence of the irradiation, the heat was scarcely perceptible, when the face was within 25 cm. of it.

The 16-candle lamp was effective at a distance of 1 m. For the arrangement of many Microscopes in a circle at a convenient distance round the source of light, the Müller lamp is most to be recommended, because the spiral form of the carbon produces equal effects in all directions.

The greatest intensity—of 60 candles—was equivalent to the best available diffused daylight, when the rays were made parallel by a condenser before falling upon the mirror.

In all the observations it was necessary for obtaining homogeneous images, unaffected by any reflex and interference phenomena, to insert immediately under the object a plate of ground-glass, or to place the preparation upon the polished side of a ground-glass slide.

* Central-Ztg. f. Optik u. Mechanik, iv. (1883) p. 206. Aus Die Elektro-Medicin in der Internat. Elektr.-Ausst. zu München im Jahre 1882 von Dr. R. Stintzing.

The objects examined were: fresh human blood, epithelium from the mouth, and saliva-corpuscles, numerous preparations (stained with colouring matters of all kinds) of muscle, nerves, epithelium, bones, skin, embryos, bacteria, "test objects" (*Pleurosigma angulatum*). Especially surprising was the faultless image of the red blood-corpuscles, an object which has hitherto for the most part withstood artificial illumination. Even with the weaker incandescent lamps, the faint hæmoglobin colour of the corpuscles showed a clearness beyond expectation.

A few more intense pigments, on the other hand, were considerably altered: in daylight saturated blue imbibitions, prepared with indigo-carmine, borax, and oxalic acid, were a dingy reddish-violet, with every kind of electric illumination, whilst objects coloured with anilin-blue were a more intense blue, and, when in thick sections, blackish blue. All coloured green with indigo and picric acid were of a decided saturated green.

A Crompton arc-lamp, of about 3000 candle-power, was found quite as advantageous as the incandescent lamps. The light, diminished (by about 15 per cent.) by an opal glass shade, and placed at a distance of 2·1 m. (in a horizontal direction) from the mirror of the Microscope, and raised 1·1 m. above it, was found the most convenient, whilst the plane mirror of Abbe's illuminating apparatus was adjusted, not on the brightest point, but on an adjoining portion of the globe. In this case the ground glass under the object was indispensable, and may always be reckoned an advantage. Where exceptionally such great brightness is requisite this illumination is to be recommended.

In order to see how far the excess of light promised advantage, the shade was removed, and the mirror adjusted on the carbons. Instead of the ground glass, which produced a field of view full of spots, a small piece of oiled tissue-paper was placed over the upper surface of the Abbe illuminating lens, and the smaller diaphragm inserted. An object, consisting of mouth-epithelium and saliva-corpuscles, observed with this illumination and Zeiss's oil-immersion 1/18 and a strong eye-piece, has perhaps given the most perfect microscopic image that has yet been seen. It was, indeed, attempted to obtain the same with direct sunlight, but with only partial success, as it was necessary to dim the sunlight by ammonio-oxide of copper.

Further to increase the illumination by a parabolic reflector appears impracticable, as the heat, which had never before been troublesome, became unbearable, even at a distance of several metres.

The whiteness of the electric light, resembling in this respect daylight, especially adapts it to the observation of such objects as are recognizable essentially by differences of colour. Fresh preparations of pathologically changed organs (cancerous and cirrhous liver), and fine shades of skin pigments of animals, were perfectly demonstrated by the incandescent lamps, and whilst enjoying the advantage of these almost non-heating lamps, by which the observer may be surrounded on all sides, there is no difficulty in undertaking the finest zootomical

preparations by its peaceful light, undisturbed by troublesome shadows of the hand and instrument.

As the spectrum of the incandescent lamp is not only continuous but incomparably more intense in the blue and violet than that of any other artificial light, the suitability of the light was tested for spectral absorption analysis. Complete success was obtained in recognizing in the blue and violet the absorption-bands of such colouring matters as had hitherto only been capable of investigation with sunlight; for instance, the three between F and H of the yellow colouring matter of the yolks of eggs, the alcoholic-ether extract being placed between the slit of the spectroscope and an Edison lamp.

Dr. M. Flesch also considers * the advantages of the electric light for microscopy.

The value of a light for microscopical purposes can be judged of by considering the causes which determine the maximum capacity of the Microscope. "The limit of resolution of the Microscope, which under present conditions cannot be extended, depends upon the illumination, and under the most favourable conditions it does not exceed with the most oblique light 3/8, or with perfectly central light 3/4, of a wave-length (about 0·55 μ) of white light. With homogeneous blue light of about 0·43 μ wave-length (Fraunhofer's line G), under the same circumstances, the above limits become reduced to about 3/10 and 6/10 respectively; that is, to about 0·15 μ and 30 μ." † The possibility of thus increasing the resolving power of the Microscope by the use of blue instead of white light, makes it desirable to introduce illuminating apparatus which will permit of the ready application of monochromatic light. It follows from the preceding that a good microscopic lamp must be rich in blue rays. This in the case of incandescent bodies is dependent upon the temperature. At 1500° C. bright blue rays are emitted, at 2000° violet rays. In the case of the electric light, the proportion of short-wave rays will vary with the strength of the current. O. E. Meyer ‡ gives the following table showing the brightness of the different lights, compared with that of the sun, the latter being reduced in intensity, through polarization, until the brightness of the yellow light was the same in each case.

	Arc Light.	Incandescent Light. (Edison's).	Gaslight.
Red	2·09	1·48	4·07
Yellow	1·00	1·00	1·00
Green	0·99	0·62	0·43
Blue-green ..	—	0·29	—
Blue	0·87	0·21	0·23
Violet	1·03	0·17	0·15
Extreme violet ..	1·21	—	—

The incandescent light contains, it will be seen, relatively, more of the blue rays than gaslight; and it will, therefore, much facilitate

* Zeitschr. f. Wiss. Mikr., i. (1884) pp. 175–81.
† Dippel's 'Das Mikroskop,' i. (1882) p. 324.
‡ Centralbl. f. Elektrotechnik, v. p. 457.

work with monochromatic light where the greater intensity compensates for the light absorbed. It also possesses the advantage of comparatively lower heat, as it can be brought very close to the object. It is also very pure, which proves useful with complicated stains, and it is very uniform.

Dr. Van Heurck, it will be remembered, has already published * the opinion that "the incandescent electric light supplies the illumination *par excellence* which the microscopist requires."

Clayton and Attout-Tailfer's Isochromatic Plates for Photomicrography.†—The different colours of the spectrum are, as is known, far from having the same reducing action on silver salts; there exists, in fact, an antagonism between their luminous intensity and photo-chemical action. It is thus that objects coloured yellow or orange (which are luminous colours) produce almost black images, whilst objects coloured blue or violet (which are dark colours) give pale and almost white tones.

Dr. E. Van Ermengem has obtained some excellent photo-micrographs by using the isochromatic plates of Clayton and Attout-Tailfer, of Paris, which in the reproduction of the Bacteria for instance do not necessitate any special device for illumination, or the use of coloured glass even when the objects are stained red with fuchsin.

According to Dr. Van Ermengem the scientific application of photography is likely to derive the best results from these plates. The methods of staining so much used at present in micrographic research have undoubtedly contributed to restrict the use of photography even where it would have been most useful. In bacterioscopical researches especially, it has been very difficult hitherto to get suitable images of certain bacteria, such as *B. tuberculosis*, which cannot be coloured with brown stains. The same was the case with preparations treated with methyl-blue or fuchsin, the most usual staining reagents. The isochromatic plates, however, enable excellent photographs of these different preparations to be obtained with equal facility. Their manipulation does not differ from that of the ordinary plates, and their sensitiveness is very great, though possibly less than that of the bromo-gelatin plates of Van Monckhoven. The sensitiveness of the plates to coloured light is due to the impregnation of the sensitized layer by a very weak solution of eosin. All the compounds do not, however, give good results, and what kind of eosin ought to be used is not yet decided.

Error in Photographing Blood-corpuscles.‡—A note on a possible source of error in photographing blood-corpuscles, by G. St. Clair, communicated to the Birmingham Philosophical Society, is a fruitless attempt to explain as an optical illusion Dr. Norris's asserted discovery by the aid of photography of a third kind of corpuscle in mammalian blood. The author invokes the principle of the forma-

* See this Journal, ii. (1882) p. 418.
† Bull. Soc. Belg. Micr., x. (1884) pp. 170–2.
‡ Nature, xxx. (1884) pp. 495 and 517.

tion of images by the passage of light through small apertures, and conceives that Dr. Norris's "colourless disks" are merely images at the end of the microscope-tube or the aperture of the eye-piece, and he seems to have taken some pains to obtain such images by placing under the Microscope a slide thickly strewn with small steel disks, and receiving the light on a screen beyond the eye-piece. Had he attempted to focus these ghosts and the real images of the disks *at the same time*, or considered a little more closely the elementary optical principles involved, we venture to say the note would never have been written.

The Tolles-Wenham Aperture Controversy.—The address * of Dr. J. D. Cox, the President of the American Society of Microscopists, is exclusively occupied with a review of the controversy between Mr. Wenham and Mr. Tolles on the aperture question, with extracts from the various papers published by them and others. Mr. Wenham was so fundamentally in the wrong throughout that controversy, not only on the merits of the question, but also in the manner in which his part of the controversy was conducted, that Dr. Cox may be, in part at least, forgiven for the relentless manner in which he recapitulates the strange optical errors which Mr. Wenham from time to time enunciated, not omitting the mishap by which—though in fact he had discovered, in 1855,† the great increase of distinctness of the more difficult diatoms when mounted in balsam and with a small hemisphere cemented over them with balsam—he after all missed the keystone of the aperture question and the important property of immersion objectives in consequence of having in some inexplicable way supposed that a glass hemisphere did not magnify the object at its centre because there was no refraction.‡

If, however, Dr. Cox, in demonstrating the correctness of the views of the American optician, felt himself obliged to deal so fully with the mistakes of his opponent, he does not shrink from paying a well-deserved tribute to Mr. Wenham in the following words:—"His authority was deservedly great. His improvements of the Microscope

* Proc. 7th Ann. Meeting Amer. Soc. Micr., 1884, pp. 5–39 (4 figs.).

† Quart. Journ. Micr. Sci., iii. (1855) p. 302.

‡ Ibid., and Mon. Micr. Journ., x. (1873) pp. 11–12. The text of Mr. Wenham's paper is as follows:—

"Now arose the question of a means of obtaining the full aperture on objects in balsam or fluid. It at once appeared that if the object was set in the centre of a sphere (or hemisphere) all rays from the central point must continue their course without deviation, and that in such a case neither the length of radius of the glass hemisphere or the refractive power of the material would influence the results. I therefore made a number of minute plano-convex lenses of various radii, some less than the 1/100th part of an inch. Such of these as turned out to be hemispheres were set exactly over a single selected diatom and balsam let in. *Before* the balsam was admitted for a well-known optical law, the object could not be seen. When a 1/5th or other object-glass was brought over this lens, the arrangement might be termed a four-system one, though the optical effect of the hemisphere as a lens was *nil*, simply because there was no refraction. The balsam object was not magnified. It occupied a like focal distance to the *dry* ones outside and the same adjustment served for either." Cf. also Mon. Micr. Journ., ix. (1873) p. 31.

and its accessories were so numerous, so beautiful, and so useful as to excite the enthusiasm of all who used the instrument. He had made himself an expert in the construction of object-glasses, and in every department of his activity he had with a noble disinterestedness made the world a free gift of his inventions."

We must take exception to one remark of Mr. Cox. It is not correct to say that Mr. Tolles "practically had to contend with the organized authority of the Royal Microscopical Society." The authority of the Society was never involved in the controversy, and the Fellows who saw the absurdity of the denial of the existence of an aperture in excess of that of 180° angular in air were at all times as numerous and influential, to say the least, as those who maintained the contrary view.

The only satisfactory point about this aperture question is that it is at last at rest, and that it is now no more incumbent upon microscopists to debate the question with objectors than it is for physicists to debate the rotundity of the earth or its rotation upon its axis.

Amphipleura pellucida resolved into "Beads." Nature of the Striæ of Diatoms.—Dr. H. Van Heurck writes to us as follows:—

The *A. pellucida* has a double system of striation, transverse and longitudinal, which has been known for some time, although the number of observers who have seen the longitudinal striæ is very limited.

Hitherto the "beads" on this diatom have not been clearly resolved, and the possibility of exhibiting them has been doubted. The matter is no longer doubtful, for I now adduce unmistakable proof—a photograph of the "beads."

In October 1883 I succeeded in producing a print on which the beads were fairly indicated, but the matter was not ripe for publication; I was proceeding with further experiments, when I was attacked by severe illness which prevented me from resuming my work during the whole of the winter.

I have recently taken up the subject again, and have succeeded in obtaining photographs, both by transmitted light and by the vertical illuminator, which suffice to clearly prove the existence of the beads, although as photographs they leave much to be desired.

If these beads are difficult to observe distinctly, they are far more difficult to photograph, so that I had almost despaired of obtaining a satisfactory print. We may, it is true, succeed in viewing the beads on the focusing screen of the photographic apparatus, and may see them distinctly, and yet on developing the image on the sensitized plate the whole appears foggy, indistinct, and valueless. Out of some fifty trials I hardly obtained one with tolerable success. I used some of the best known objectives, such as the 1/12 and 1/18 of Zeiss, the 1/10 of Tolles, and the 1/8 (1·47 N.A.) of Powell and Lealand, all homogeneous immersions, and, notwithstanding, the results were nearly always worthless. I attributed these failures to the "chemical" focus of the objectives, but I have since found that the real explanation was in the fact that the objectives were not equal to the task.

My success in photographing the beads has been due to the use

of the incandescent electric lamp; still, I hope to improve upon these results. Drummond's light in my hands was not satisfactory.

I send for comparison a print of *A. Lindheimeri* Grun., a species intimately allied to *A. pellucida*, differing only in being larger and in having bolder striation. The details shown on *A. Lindheimeri* will assist the interpretation of the print of *A. pellucida*.

It will be observed that in both species the longitudinal lines are not straight but wavy, which is due to the fact that the beads or alveoli are not opposite each other, but alternate irregularly. This is also observed in the photographs (*vide* photo. E, negative No. 789) produced by Dr. Woodward, of the *Rhomboides Van Heurckia* Bréb. This arrangement of the striation combined with the presence of the rudiment of the median nodule, which on my prints is well seen, confirms the opinion given by Mr. Kitton in a note on the text of my Synopsis, which he has been good enough to read, that the genus *Amphipleura* presents no essential generic character which would differentiate it from the genus *Van Heurckia* (the existence of the keels not being demonstrable and their notification appearing to him due to an error of observation), the species of the genus *Amphipleura* should therefore be comprised in the genus *Van Heurckia*.

I take advantage of this opportunity to explain my opinion on the nature of the striæ of diatoms, striæ which in many cases are only seen by the help of oblique condensers.

I cannot admit that these striæ are illusory.

The beads of the diatoms are really alveoli or cavities in the thickness of the valves; between the cavities are thickened parts, and it is these thickenings which appear as striæ. These striæ are stronger or weaker according to the separation of the alveoli, and also according as the siliceous bands between them are more or less thick.

I have explained this point in detail, as well as my other views on the structure of the valves, on pages 35–7 of the text of my Synopsis, which were printed early this summer and of which a copy is deposited with the Secretary of the Belgian Microscopical Society.

By way of summary of this note, I state: (1) that the *A. pellucida* as well as the *A. Lindheimeri* consist of alveoli arranged in series at right angles; the alveoli are arranged in regular transverse series and in wavy longitudinal series. (2) Our present objectives suffice to elucidate the structure of the diatom valves, provided we employ media of sufficiently high refraction, and suitable illumination. (3) The striæ exhibited by an improper illumination or by an objective whose aperture is too low to resolve the alveoli or the "beads" of *A. pellucida*, are due to the thickened parts of the valve, that is, to the parts situated between the beads and the alveoli.

The photographs I send herewith are:

(1) *A. pellucida* produced with Powell and Lealand's oil-imm. 1/8, illuminated by incandescent electric lamp,* and the vertical

* The illumination was obtained by means of the Nelson-Mayall-Van Heurck lamp,—thus I name the Nelson-Mayall lamp, in which I have replaced the lamp-wick by a Swan lamp of 6 volts. The great facility of movement provided in this lamp renders it of much service in these extremely delicate researches.

illuminator. The preparation silvered by Dr. A. Y. Moore's process.

A. Print from the original negative, 800 diam.

B. Print from negative enlarged to about 2850 diam.

C. Print magnified to 7000 diam., with Ross's Rapid Symmetrical, without diaphragm, by oxyhydrogen light.

(2) *A. Lindheimeri* Grun., medium of index 2·4, Zeiss's 1/18, incandescent electric light nearly axial, full aperture of Powell and Lealand's achromatic condenser.

A. Print from original negative.

B. An enlargement of the same.

American Association for the Advancement of Science.
[Report of the Philadelphia Meeting (probable abolition of the Section of Histology and Microscopy).]
Science Record, II. (1884) pp. 235–48.
Amer. Mon. Micr. Journ., V. (1884) pp. 175–6, 181–3 (Address of Prof. Wormley, V.P.).
Science, IV. (1884) pp. 342–3.
Micr. Bulletin, I. (1884) pp. 33–4, 46.
The Microscope, IV. (1884) pp. 237–8.

American Society of Microscopists.
[Report of Rochester Meeting—Remarks of Dr. Dallinger.]
Amer. Mon. Micr. Journ., V. (1884) pp. 161–73, 174–5.
Microscope, IV. (1884) pp. 193–5, 204–5, 206, 208, 209, 210, 228–31, 234–5 (under the headings "The Great Lights of the Past; where are they?" and "What our Friends say," "To See is to Believe," and "The Working Session").
Science Record, II. (1884) pp. 206–7, 248–9.
Micr. Bulletin, I. (1884) p. 41.

Atwood, F.—New Apparatus for Photo-micrography. [*Post.*]
Amer. Mon. Micr. Journ., V. (1884) p. 170.

Bausch, E.—Binocular Microscope. [*Ante*, p. 607.]
Specification of U.S.A. Patent, No. 293,217, 12th February, 1884.
„ „ The Society Screw. [*Post.*]
Micr. Bulletin, I. (1884) p. 40.

Bertrand, E.—Sur un nouveau prisme polarisateur. (On a new Polarising Prism.) [*Supra*, p. 965.] *Comptes Rendus*, XCIX. (1884) pp. 538–40.

Biological Laboratory at Health Exhibition. [*Ante*, p. 808.]
Sci.-Gossip (1884) p. 233.

Blackham, G. E.—Memoir of Robert B. Tolles.
Proc. 7th Ann. Meeting Amer. Soc. Micr., 1884, pp. 41–6.
Amer. Mon. Micr. Journ., V. (1884) pp. 167–8.
The Microscope, IV. (1884) pp. 202–4.

Bradbury, W.—The Achromatic Object-glass. XXXVI.
Engl. Mech., XL. (1884) pp. 232–3.

Brayley, E. B. H.—The Bristol Microscopical Society.
[In contradiction of the statement that there was no such Society.]
Engl. Mech., XL. (1884) p. 239.

Cox, J. D.—Annual Address of the President to the Rochester Meeting of the American Society of Microscopists. Robert B. Tolles and the Angular Aperture question. [*Supra*, p. 970.]
Proc. 7th Ann. Meeting Amer. Soc. Micr., 1884, pp. 5–39 (4 figs.).

D., E. T.—Graphic Microscopy. X. Eggs of House-fly. XI. Sori of Fern: *Marattia alata*. *Sci.-Gossip*, 1884, pp. 217–8 (1 pl.), 241–2 (1 pl.).

DALLINGER, W. H.—Researches on the Origin and Life-histories of the least and lowest living things.

[The full lecture—abstract, *ante*, p. 721.]

Nature, XXX. (1884) pp. 619-22 (1 fig.), 645-8.

" " See American Society of Microscopists.

DAVIS, G. E.—To our Readers.

[Announcing the suspension of the 'Microscopical News.']

Micr. News, IV. (1884) pp. 267-8.

ENGELMANN, T. W.—Recherches sur les relations quantitatives entre l'absorption de la lumière et l'assimilation dans les cellules végétales. (Researches on the quantitative relations between the absorption of light and assimilation in plant cells.)

[Version in French of German paper noted *ante*, p. 301. Describes the "microspectral photometer, an apparatus for quantitative microspectral analysis."] [*Post.*]

Arch. Néerl. Sci. Exact. and Nat., XIX. (1884) pp. 186-206.

F. R. M. S.—The Diatomescope and Mr. E. M. Nelson—An oblique illuminator for the Microscope wanted. [*Supra*, p. 961.]

Engl. Mech., XL. (1884) pp. 198-9, 263-4 (1 fig.).

FINDON, C. J. B.—The Diatomescope. *Engl. Mech.*, XL. (1884) p. 264.

FISCHER, G.—See Guébhard, A.

"Grey Beard."—The Annual Proceedings [of the American Society of Microscopists].

[Deprecating complaints of delay in publication.]

The Microscope, IV. (1884) p. 223.

GUÉBHARD'S (A.) Artikel Ueber das Vergrösserungs-vermögen der optischen Instrumente, Anhang zu, aus französischen Quellen zuzammengestellt von G. Fischer. (Appendix to Guébhard's article, *ante*, p. 810, on the magnifying power of Optical Instruments. Compiled from French sources by G. Fischer.) [*Post.*]

Central-Ztg. f. Optik u. Mech., V. (1884) pp. 217-20 (3 figs.).

GUNDLACH, E.—Improvement in Objectives. [*Post.*]

Amer. Mon. Micr. Journ., V. (1884) pp. 168-70.

HAYCRAFT, J. B.—A Model Lens for use in Class Demonstrations.

Nature, XXX. (1884) p. 543 (1 fig.).

HITCHCOCK, R.—Recent Studies on the theory of the Microscope, and their practical results as regards the use of the Microscope in scientific investigations.

Amer. Mon. Micr. Journ., V. (1884) pp. 191-6.

" " The Electric Light for the Microscope.

[Mr. Walmsley's exhibit at the Philadelphia Meeting of the Amer. Assoc. Adv. Sci., &c.]

Amer. Mon. Micr. Journ., V. (1884) p. 199.

HOFMEISTER, V.—See Siedamgrotzky, O.

JAMES, F. L.—Instructions for making a neutral-tint Camera lucida.

[Round cover-glass and pill-box.]

Amer. Mon. Micr. Journ., V. (1884) p. 179, from 'National Druggist.'

JULIEN, A. A.—An Immersion Apparatus for the determination of the temperature of the critical point in the fluid cavities of minerals. [*Post.*]

Amer. Mon. Micr. Journ., V. (1884) pp. 189-90.

Science, IV. (1884) pp. 342-3.

KINGSLEY, J. S.—Journal of R. Microscopical Society.

Science Record, II. (1884) p. 187.

" " [Answer to question "Which is the best Microscope?"—the answer being Hartnack or Zeiss if price is taken into consideration. "Almost every American student who goes to Europe to study biology gets rid of his American stand, and comes back armed with instruments of one of the two makers named."]

Science Record, II. (1884) p. 210.

KINGSLEY, J. S.—Workers and their Instruments.
[List of 31 United States and Canadian working microscopists with the Microscopes they use, being German 24, American 11, and English 2. "It may be that these men who have chosen the despised instruments of Europe are fools, and that they are not capable of appreciating a good article when they see it; but if we are to judge by their published works, we have no evidence of any dementia or idiocy."
Science Record, II. (1884) pp. 261–2.
" " [Suspension of publication of the 'Science Record.']
Science Record, II. (1884) pp. 272–5.
'Lens,' proposed resuscitation of, by Illinois State Microscopical Society.
Science Record, II. (1884) p. 207.

MARTIUS.—Eine Methode zur absoluten Frequenzbestimmung der Flimmerbewegung auf stroboskopischem Wege. (A method for determining the absolute frequency of the movement of the cilia by means of the stroboscope.) [*Post.*]
Arch. f. Anat. u. Physiol., 1884, *Physiol. Abtheil.*, pp. 456–60.

MILLER, M. N.—Photographing Diatoms and diffraction gratings.
[Reply to query as to "how to successfully photograph a diatom its natural size, preserving if possible the detailed structure in the photo." Suggests first making a photomicrographic negative × 200–500, and then making a microphotographic positive from the negative, which with a lens would show the detail of the larger picture.]
Engl. Mech., XL. (1884) p. 158.

NELSON, E. M.—Illumination for the Microscope. II., III. [*Post.*]
Engl. Mech., XL. (1884) pp. 157–8 (3 figs.), 263 (6 figs.), (in part).
" " On a Hydrostatic Fine Adjustment. [*Ante*, p. 800.]
Journ. Quek. Micr. Club, II. (1884) pp. 57–8 (3 figs.), 84–5.
" " The Diatomescope. [*Supra*, p. 962.]
Engl. Mech., XL. (1884) pp. 157 and 242.
" " " [Rejoinder to F. R. M. S. Also remarks on oblique illuminators, which he thinks should "be consigned to the dust-bin."]
Engl. Mech., XL. (1884) p. 242.

OSBORNE, S. G.—The Diatomescope. [*Supra*, p. 961.]
Engl. Mech., XL. (1884) pp. 180–1.
" " " [Comment on "F. R. M. S.'s" letter, and that there is no difficulty in fitting the apparatus to a substage.]
Engl. Mech., XL. (1884) p. 221.

QUEEN, J. W.—Some recent devices for quickly changing objectives.
[All have appeared *ante*, except Fasoldt, *supra*, p. 959.]
Micr. Bulletin, I. (1884) pp. 34–6 (6 figs.), 42–3 (5 figs.).

Queen's (J. W. & Co.) New Dissecting Stand. [*Post.*]
Micr. Bulletin, I. (1884) p. 38 (1 fig.).
" " New Class Microscope.
[Described II. (1882) p. 398.]
Micr. Bulletin, I. (1884) p. 47 (1 fig.).

[REDDING, T. B.].—The Microscope. II.
Indianopolis Journ., 12th October, 1884, p. 7.

ROYSTON-PIGOTT, G. W.—Diatomescope experiments.
[Examples showing the capabilities of the instrument, with drawings of the appearance of *P. angulatum*.]
Engl. Mech., XL. (1884) p. 239 (2 figs.).

SIEDAMGROTZKY, O., and V. HOFMEISTER.—Anleitung zur mikroskopischen und chemischen Diagnostik der Krankheiten der Hausthiere für Thierärzte und Landwirthe. (Guide to the microscopical and chemical diagnosis of the diseases of domestic animals, for veterinary surgeons and farmers.) 2nd ed.
[Contains general remarks on the use of the Microscope, pp. 4–16, and the principal impurities of microscopical preparations.]
iv. and 227 pp. (56 figs.), 8vo, Dresden, 1884.

SMITH, J. LAWRENCE, Memoir of.
[Inventor of the Inverted Microscope.]
Proc. Amer. Acad. Arts and Sci., XIX. (1884) pp. 535–9.

Society Screw, Committee appointed by American Society of Microscopists as to. [*Post.*] *Amer. Mon. Micr. Journ.*, V. (1884) p. 172.

Spencer, C. A., and Tolles, R. B., Proposed Memorials to.
Amer. Mon. Micr. Journ., V. (1884) p. 171.

Spencer's (H. R. & Co.) Objective Protector. [*Supra*, p. 959.]
Amer. Mon. Micr. Journ., V. (1884) p. 200.

STRICKER, S.—Ueber das elektrische Licht als Hülfsmittel für den mikroskopischen Unterricht. (On the electric light as an aid for microscopical instruction.)
Wiener Med. Jahrbücher, 1883, pp. 463–75.

Swift & Son's New 1-in. Objective, 40° Angle of Aperture, "constructed on an "entirely new optical principle, whereby extraordinary depth of focus and "flatness of field combined with resolving power is obtained. This objective "works beautifully with the Binocular Microscope, and owing to its large "angular aperture is rendered the best objective extant for use with the Lan-"tern-projecting Microscope." *Sci.-Gossip*, 1884, p. cxvi. (Advt.).

TAYLOR, J. E.—The Aquarium: its Inhabitants, Structure, and Management. New ed.
[Contains "The Aquarium as a Nursery for the Microscope," pp. 113–38.]
xvi. and 316 pp. (239 figs.), 8vo, London, 1884.

Tolles, R. B.—See Spencer, C. A.

WALLICH, G. C.—An improved form of "Condenser" for the Microscope. [*Supra*, p. 962.] *Specification of Patent*, No. 7639, 13th May, 1884.

WATTS, H.—[Postal Microscopical Society formed in Australia.]
Journ. of Micr., III. (1884) pp. 261–2.

WEST, T.—Blackground illumination [is a poor way of getting at the facts which a specimen may disclose; so also is polarizing . . . .]
Journ. of Microscopy, III. (1884) p. 247.

WILSON, W. L.—A cheap Microscope holder.
["It costs about a penny, and works as well as a guinea one with universal brass hinge. It consists of a turned American clothes-peg, held between two upright strips of wood, and these are bound at the top with an elastic band, which is passed three times round them. The bottom end of the strip is held by one screw to a block of wood. The clothes-peg thus has every motion, up and down between the strips of wood, round upon its own axis, and sideways on a hinge."]
Sci.-Gossip, 1884, p. 260.

WOODWARD, B. B.—The Microscope: how to make and how to use one.
Young England, 1884, pp. 213–5 (3 figs.).

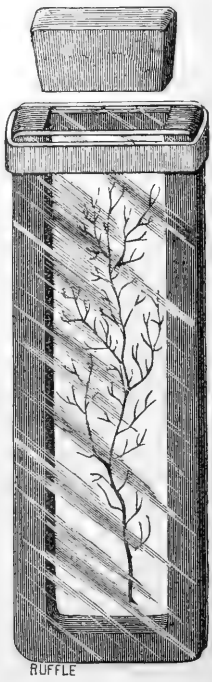
Woodward, J. J., death of. *Amer. Mon. Micr. Journ.*, V. (1884) pp. 173–4.
Cinc. Med. News, XVII. (1884) pp. 571–5.

WRAY, L., Jun.—An Improved Microscope Screen. [*Supra*, p. 956.]
Engl. Mech., XL. (1884) p. 180 (1 fig.).

β. Collecting, Mounting and Examining Objects, &c.

Hardy's Collecting Bottle.—We are now able to give a woodcut (fig. 161) of one of Mr. J. D. Hardy's bottles for collecting and examining aquatic specimens (6 in. × 2 in. × 3/8 in.) described *ante*, p. 803. At the October meeting of the Society, at which it was exhibited, the opinion was very generally expressed that the bottle was a most useful contrivance, and one that it was somewhat surprising had not been adopted long ago.

Fig. 161.



Collecting Desmids.*—The Rev. F. Wolle gives the following directions for collecting desmids:—

"The outfit need not consist of more than a nest of four or five tin cans (tomato or fruit), one within the other for convenience of carriage; ten or a dozen wide-mouthed vials, and a small ring-net made of fine muslin at the end of a rod about four feet in length. Should a boat be needed, it can usually be hired on the spot. After selecting what seems to be a good locality, drag the net a few feet among the grass and mosses, allow the bulk of the water to drain through the muslin, and then empty the residue into one of the cans; repeat this process as often as may be desirable. Ten or fifteen minutes after the cans have been filled, most of the surface-water may be poured off, and the remainder transferred to a glass vial, when the solid contents will gradually sink, and the superfluous water can be again poured off and the vessel filled up with deposits from other vials. In shallow places what is known as swamp-moss (*Sphagnum*), bladder-wort (*Utricularia*), water milfoil (*Myriophyllum*), or other finely cut-leaf water-plants are likely to abound; these should be lifted in the hand, and the water drained or squeezed from them into a tin can to be subsequently treated as already stated.

A few drops of carbolic acid in each vial, just enough to make its presence perceptible, will preserve the contents for months, and even years, from deterioration: the green colouring matter (chlorophyll) may fade, but this, in the case of desmids, is of little importance; nevertheless, when practicable, always examine the materials when fresh. When dried on paper for the herbarium, the specimens can still, after being moistened with water, be microscopically examined, but not with the best results, since the drying up is apt to collapse or otherwise distort the cells."

* Wolle, F., 'Desmids of the United States.' See this Journal, *ante*, p. 791.

Preparing Embryos.*—J. A. Ryder points out that in working with vertebrate materials, hardening and killing should be done in such a way as not to distort the axis of the embryos, in order that the knife may be adjusted so as to cut in any desired plane with accuracy. The imbedding must be as homogeneous as possible; for this purpose saturating the object with paraffin has been found to be the best, so that evenly thin sections may be produced. The methods of Bütschli, Plateau, Calberla, Duval, all serve this purpose, and their relative values are probably expressed in about the order in which they stand. Staining is best accomplished by dyeing the object as a whole; mounting should be done serially and with the ribbon method.

Method of Studying the Amphibian Brain.†—Prof. H. F. Osborn hardens the brain in Müller's fluid (bichromate of potash), the ventricles being fully injected. After the usual alcoholic treatment, the brain is placed for one week in a carmine solution, then for twenty-four hours in acetic acid.

The imbedding mass is prepared by shaking the contents of an egg with three drops of glycerin. After soaking in this mass, the brain is placed in position, and hardened in the vapour of boiling 80 per cent. alcohol. The mass is then placed for one week in absolute alcohol.

Sections are made under alcohol with a Jung's microtome, fifty or sixty sections collecting on the razor in alcohol are then floated at once, in order, upon the slide. To keep them in place, they are covered with old-fashioned blotting-paper (cigarette-paper was suggested as better by Dr. C. S. Minot) and treated with alcohol and oil of cloves through the papers, a device which may prove convenient in many cases.

Preparing Planarians and their Eggs.‡—In the preparation of Planarians for histological study, J. Jijima recommends corrosive sublimate as the only good preservative agent. The worms are placed in a shallow plate, *without water*, and a saturated solution of corrosive sublimate, heated almost to boiling, is poured over them. In this way they are killed so quickly that they do not have time to contract. They are left thirty minutes or less in the sublimate, then placed in water for an hour or more. The water should be changed several times, in order to remove all the sublimate; otherwise it forms needle-like crystals, which impair or ruin the preparation. Three grades of alcohol ("weak, strong, and absolute") are used in hardening, in each of which the object should be left at least forty-eight hours before staining. Borax-carmine (probably the alcoholic solution) is recommended as a staining agent; a dilute solution is used in preference to the full strength, and allowed to act from three

* Amer. Mon. Micr. Journ., v. (1884) pp. 190–1.

† Science, iv. (1884) p. 343. Abstract of paper read before the Philadelphia Meeting of the Amer. Assoc. Adv. Sci. Also Amer. Mon. Micr. Journ., v. (1884) p. 188.

‡ Zeitschr. f. Wiss. Zool., xl. (1884) pp. 359–464 (4 pls.). Amer. Natural., xviii. (1884) pp. 1068–9.

to four days. For preservation as museum specimens, they are killed with strong nitric acid (about 50 per cent.), in which they die fully extended.

Preparation of the Ova.—The egg-capsules of fresh-water Planarians are generally attached to water-plants by means of a white secretion. The ova are very small and few in number, and are scattered among an immense number of yolk-cells. The ova are completely naked, and a little smaller than the yolk-cells, and are not easily isolated. When cleavage begins, a large number of yolk-cells surround the ovum, and form with it a mass large enough to be seen with the naked eye. Jijima adopts the following mode of isolation and preparation:—By the aid of two sharp dissecting needles, the egg-capsule is opened on a slide in dilute acetic acid (2 per cent.). The contents flow out, and the empty capsule is then removed. The slide is next shaken, in order to isolate the ova so far as possible from the yolk-cells. This process detaches many of the yolk-cells, but not all; each ovum will still have yolk-cells adhering to it, and will now appear to the naked eye as a minute white mass. A cover-glass supported by wax feet or by slips of paper is now placed over them. After about thirty minutes the acetic acid is carefully removed by the aid of small pieces of blotting-paper placed at one side of the cover, and replaced by alcohol (70 per cent.). The withdrawal of the acetic acid must be as slow as possible, otherwise the ova will be lost. After an hour the alcohol is replaced by a stronger grade (90 per cent.), in which the ova should remain two hours. Finally, the alcohol is replaced by a mixture of glycerin and water in equal parts, and this in turn by pure glycerin. The preparation is now complete, and the cover-glass may be fixed in the usual way by means of lac.

In order to obtain sections of embryos which are too small to be treated individually, the contents of the capsule may be hardened *in toto* in chromic acid (1 per cent.), which renders them less brittle than corrosive sublimate.

The changes which take place in the ovum initiatory to cleavage are very difficult to trace, as they are generally completed before the cocoon is laid. In some cases ova were found in fresh laid capsules, which showed the germinal vesicle still unchanged; others were found to have two nuclei, supposed to be derivatives from the first cleavage nucleus. This stage of two nuclei was also found in some cocoons taken directly from the penial sheath, in which the cocoon formation takes place. It is therefore not quite certain when fecundation takes place, whether in the cocoon or before its formation.

Starch Injection Mass.*—Prof. S. H. Gage considers that a coarse injection mass which is cold-flowing, which may be forced nearly to the capillaries, rapidly hardening after injection and leaving the vessels flexible, which does not dull dissecting instruments, and is suitable for permanent dry or alcoholic preparations, being at the same time simple in its manipulation, cleanly and economical, is fully

* Amer. Natural., xviii. (1884) pp. 958–60, from 'New York Medical Journal,' 7th June, 1884.

realized in the starch mass introduced by A. Pansch, and since recommended, with various modifications, by Wikszemski, Dalla Rossa, Meyer, and Browning.*

As starch is insoluble in alcohol and cold water, it becomes hard when injected into the blood-vessels simply by the exudation of the liquid with which it is mixed. (That the starch-grains forming the mass remain entirely unchanged may be easily demonstrated by making a microscopic examination of the contents of an injected vessel.)

The mass originally recommended by Pansch consisted of wheat-flour and cold water, to which was added a sufficient quantity of the desired colouring matter. Later experiments have shown that pure starch is better than flour.

Mass for Ordinary Injections.—Dry starch ("laundry" is good), 1 vol.; 2½ per cent. aqueous solution of chloral hydrate, 1 vol.; 95 per cent. alcohol,† 1/4 vol.; colour, 1/4 vol. Since almost any animal injected may afford some organ worth preserving, it seems better to employ permanent colours for tinging the mass. Among those which are available, probably vermilion, red lead, ultramarine, chrome, orange, yellow or green are preferable.

Preparation of the Colour.—Dry colour, 1 vol.; glycerin, 1 vol.; 95 per cent. alcohol, 1 vol. To avoid lumps, which would clog the cannulæ, or small vessels, the colour is thoroughly ground with the liquid in a mortar. It is stored in a well-stoppered bottle, and is prepared for use simply by shaking.

Special Mass.—For the injection of brains, and, perhaps, for other rapidly perishing specimens, it seems best, as suggested by Wilder, to use strong preservatives in preparing the mass. Corn starch (that used for food), 1 vol.; 5 per cent. aqueous solution of chloral hydrate, 1/2 vol.; 95 per cent. alcohol, 3/4 vol.; colour, 1/4 vol. For convenience and economy, a considerable quantity of either of the masses described above may be prepared at once, and kept in a wide-mouthed specimen or fruit jar. A smooth stick in each jar is convenient for stirring the mass, which should always be done just before using. The syringe may be filled directly from the jar, and any mass remaining in the syringe after the injection is finished may be returned to the jar.

If it is desired to have the mass enter very fine vessels, some of the stock mass, as given above, diluted with an equal volume of water or chloral solution, may be injected first, and immediately followed by the undiluted mass, or for large animals, a mass containing twice the usual amount of starch. In whatever form the starch is used, it is necessary to work somewhat expeditiously, because the

* See A. Pansch, Arch. f. Anat. und Entwickl., 1877, pp. 480–2, and 1881, pp. 76–8; Wikszemski, ibid., 1880, pp. 232–4; Dalla Rossa, ibid., pp. 371–7; H. v. Meyer, ibid., 1882, pp. 60–1, and 1883, pp. 265–6; Browning, 'Annals of Anatomy and Surgery,' 1884, pp. 24–5.

† The chloral and alcohol prevent fermentation in the mass when it is kept in stock; the alcohol also increases the fluidity and likewise the more rapid hardening in the vessels; both, of course, act as a preservative upon the animal injected.

exudation of the liquid in the smaller vessels takes place so rapidly that the mass hardens very quickly in them. The larger the vessel the more slowly, of course, do the exudation and consequently the hardening take place. It sometimes happens that large vessels, like the aorta, are not fully distended after the exudation of the liquid. In this case some mass containing double the ordinary amount of starch can be advantageously injected in two hours or longer after the first injection.

Dry Preparations.—Finally, if vessels injected with the starch mass are dissected free, soaked a day or two in Wickersheimer's preservative, and then dried, they retain their form, and to a great degree their flexibility.

Imbedding in Sticks of Paraffin.*—J. S. Kingsley describes a convenient method of imbedding. Small sticks of paraffin, fitting the holder of the microtome, are cast in quantity in suitable paper moulds and are laid aside until wanted. When it is desired to imbed an object it is treated as for any paraffin imbedding. When thoroughly impregnated with paraffin, a bit of wire is heated and with it a hole is bored in one of the sticks of paraffin and the object is quickly inserted.

This method is especially adapted for cutting transverse sections of elongated objects such as tadpoles, and furthermore it obviates all danger of overheating the specimen. With objects of spherical shape, of which sections are desired in any particular plane, it affords no especial advantage.

"Microtomy."†—J. A. Ryder suggests the word "microtomy" for the "new art" which has within a very recent period been developed, including both the processes preliminary to the actual cutting of sections, and also those necessary for mounting.

Gray's Ether Freezing Microtome.—The improvements in this microtome, the design of the Rev. Metcalfe Gray, consist in the holder for the knife, and in the addition of guides, that the direction of the cuts may be uniform, while steadiness is secured.

All workers with tools know how important it is that they should be held at the proper angle to the work, in order to secure the best results, and the fault of many if not all section-cutters in which plane-irons or chisels are used is that there are no means whereby this object may be attained, the results in consequence depending upon knowledge and skill, which many to whom sections would be most valuable have no time to acquire.

To meet this difficulty an iron duplex plane has been altered by cutting away the connecting bar in front of the end slot, so that the iron is fixed firmly at the proper angle, and has the greater part of its front surface clear, up which the sections as they are cut may slide without obstruction. The cutting edge of the iron is ground level on a piece of plate glass with emery powder, and afterwards sharpened.

* Science Record, ii. (1884) p. 175.
† Amer. Mon. Micr. Journ., v. (1884) pp. 190–1.

The plane thus altered works upon two strips of plate glass, which can be adjusted to the width of the iron, and easily renewed if broken, being kept in position by wooden bars which act as guides to the plane.

The inside edges of the guides just allow the plane to work freely upon the glass, and the edges of the glass are adjusted carefully so as to allow the plane-iron to pass between without touching them.

The top of the table is roughened with a file, and not grooved, in order to secure more evenly and firmly the substance to be cut, and in the spray small brass nozzles are used which can be renewed when desired.

In use, the whole instrument is clamped to the left-hand corner of a table, with the side towards the operator. The cutting edge of the plane-iron being fixed about 3/16 in. above the top of the table, and the substance to be cut being frozen, the operator firmly grasps the plane with his right hand, and causes it to travel backwards and forwards between the guides, while he leans over the instrument, and with his left hand, before each cut, turns the large screw-head through one or more divisions, according to the thickness of the section desired. In turning the screw-head, the worker will be guided by the nick in the little brass screw in the end of the wooden base of the instrument.

Any advantages of a diagonal cut may be secured by placing the substance to be operated upon in a diagonal position upon the table.

Preparing Picrocarmine and Indigo-Carmine.*—Dr. F. L. James writes that whilst picrocarmine is one of the most valuable staining agents, the formula for preparing it, "for some unaccountable reason, is not given in any of the standard works on the subject, and microscopists are forced to purchase it from dealers at exorbitant prices," and he therefore gives the following as the process used in his laboratory for preparing a very satisfactory article.

"Dissolve 15 grains of the best carmine in the smallest quantity possible of strong water of ammonia, and add distilled water enough to make one ounce of the solution. In a separate vessel dissolve 75 grains of picric acid in the smallest amount of boiling distilled water, making a saturated solution. When cold pour the two solutions together, and let stand in a closely stoppered bottle for several days, giving it an occasional shake. At the expiration of four or five days filter the solution, and pour the filtrate into flat dishes; saucers or soup-plates will do. Cover with a plate of glass close enough to keep out dust, but not so closely as to prevent evaporation. Put in a moderately warm place, and let stand until the fluid has entirely evaporated, leaving a crop of fine brickdust-red crystals. These should be collected, thoroughly dried, and preserved. When required for use, dissolve in about fifty times their weight of distilled water, filter the solution, and keep in glass-stoppered vials. Do not make more than an ounce of the solution at once, as a little of it goes a long way."

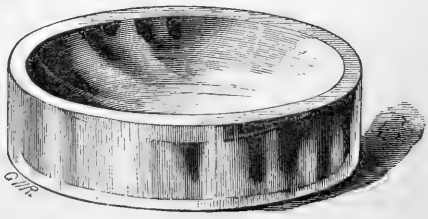
* Amer. Mon. Micr. Journ., v. (1884) pp. 178-9 and 199, from 'National Druggist.'

"Another stain that the histologist, and especially the student of micro-botany, frequently has occasion to use, is the so-called indigo-carmine, or sulph-indigotate of potash solution. Like the foregoing (picrocarmine) the text-books content themselves with recommending it, but giving no working formula for preparing it.

The following process gives a brilliant beautiful blue that works well with almost any kind of preparation, and is most useful in double staining of vegetable sections. Take of the best indigo, in lump, 30 grains. Powder in a capsule, and dry thoroughly in a water bath. When perfectly dry, add 2 drachms (by weight) of fuming (Nordhausen) sulphuric acid, adding it drop by drop, and stirring with a glass rod. As the indigo swells under this treatment, a large capsule is necessary. The whole of the acid having been added, stir well, cover, and let stand for twenty-four hours. Transfer to a tall flask, and add 3 ounces of distilled water. Let stand for four days, giving the flask an occasional shake. A magnificent blue colour is now obtained, but its acidity prevents its being used in this condition. The solution must now be neutralized by the addition of carbonate of potash (or soda) added cautiously, with frequent testings, as an excess of the alkali causes the separation of the indigo in a doughy mass (which can be redissolved, however). Filter the neutralized solution, and evaporate to dryness. For use, dissolve in fifty times its weight of distilled water."

Mercer's Solid Watch-glass.*—Dr. A. C. Mercer uses the "Syracuse Solid Watch-glass" (fig. 162) as a bath, or staining or dissecting dish for the histological laboratory. It rests solidly upon the table or stage, and is not liable to be overturned and its contents spilled. It is transparent and can be used over black, white, or coloured paper, enabling the student to use such backgrounds for his work as will permit him to watch its progress to the best advantage. Transparent tissues can be examined in it from time to time, or dissected and studied on the stage while in water, alcohol, oil of cloves, or other bath, enabling the student to reject unsatisfactory specimens at any step in the process of preparation.

FIG. 162.



When the top and bottom edges are cut, one watch-glass rests dust-tight upon another, and a piece of plate glass will fit accurately over it as a cover. In such a watch glass, covered, specimens may remain for long staining or soaking, without loss of fluid by evaporation. When the concave surfaces are polished, the watch-glass is as clear as a lens, and becomes a perfect receptacle for transparent dissecting material on the stage.

* The Microscope, iv. (1884) pp. 676–7.

Cheap method of making Absolute Alcohol.*—B. Sharp describes a cheap method of making absolute alcohol, from the strong (95 per cent.) spirit, used in Prof. Ranvier's laboratory in Paris.

A wide-mouthed bottle is taken, holding about a litre, and three-quarters filled with strong alcohol. A mass of pulverized cupric sulphate ($Cu\ SO_4 + 5\ Aq$) is heated to a red heat in order to drive off the water of crystallization. This is poured, when cool, into the alcohol, the mouth of the bottle quickly closed, and the whole shaken. The cupric sulphate is insoluble in alcohol, but has an affinity for the water contained in it, and the water is consequently taken up, and the cupric sulphate becomes bluish. When this has stood—with occasional shakings—for a day or so, decant, and repeat the operation, especially if there is very much of a bluish colour in the sediments. When finished a drop of alcohol can be mixed with a drop of turpentine on an object-glass, and if there be no particles of water to be seen under the Microscope, the alcohol is absolute enough for all practical purposes.

Arranging Sections and Diatoms in Series.†—P. Francotte has modified the method of Dr. Van Heurck ("to render it more practical") as follows:—

(1) Dissolve (warm) from 7–10 gr. of glue in 100 gr. of water (gelatin gives equally good results). A yellowish liquid is obtained which becomes perfectly clear on cooling; filter.

(2) Spread this solution on the slide, in the same way as with collodion or by means of a brush; arrange the sections on the glass while damp, and let it dry protected from the dust. To hasten evaporation the preparation may be placed in a water-bath, or better still, in an oven (at a temperature from 35° to 40° C.).

(3) When dry, warm gently over a lamp. The paraffin is removed by turpentine.

(4) Apply the cover-glass coated with liquid balsam.

The turpentine should be washed with absolute alcohol, and then the cover-glass coated with glycerin should be fixed if it is desired to preserve the preparation in the latter reagent. If the object has not been previously stained the sections can be very well stained by a reagent which is dissolved in alcohol (hæmatoxylin, eosin, anilin dyes, &c.), alcohol not dissolving either glue or gelatin. It would not be possible to use a staining agent in an aqueous solution unless the sections were previously washed with tannic acid, which would disadvantageously complicate the process.

The method recommends itself to the author by the ease with which the fixing liquid can be obtained; the sections always adhere perfectly; no displacement is to be feared; in washing, ether, chloroform, and oil of cloves can be used; the mounting can be in balsam, glycerin, or any other reagent. The wrinkles made in cutting are effaced without difficulty. Sections obtained by imbedding in gum, albumen, soap, or celloidin, can also be arranged by this method, but

* Proc. Acad. Nat. Sci. Philad., 1884, p. 27.
† Bull. Soc. Belg. Micr., x. (1884) pp. 137–41.

in this case they must be previously passed through distilled water, and placed on the glass while still wet with the solution of glue; to avoid distortion of the tissues, evaporation must only be allowed until desiccation begins; then treat with strong alcohol, which precipitating the glue, produces perfect adherence between the sections and the glass.

A very simple method described by Dr. Flögel also deserves to be known, as it may be useful for arranging sections of objects imbedded in paraffin. The process is as follows:—5 gr. of gum arabic are dissolved in 100 gr. of water; this solution is poured over the entire surface of a perfectly clean glass slide, and the excess of liquid run off by holding the slide vertically.

The operation may then be conducted in two ways.

(1) The sections are arranged upon a perfectly dry surface; then by breathing upon it, the thin layer of gum is dissolved and the sections sink into it; it is again allowed to dry, which takes place rapidly. The paraffin is removed by benzol, and the cover-glass coated with balsam is put on as previously described.

(2) The sections are arranged on the wet slide to which they adhere as the water evaporates; the desiccation being complete they are finished as in the previous case.

For thin and delicate sections the first method is preferable. For sections of considerable size and thickness, the second should be employed.

Balsam of Tolu for Mounting.*—C. H. Kain recommends balsam of tolu for mounting, as having a higher index than styrax. It has some colour, but for such purposes as mounting diatoms, where only a thin layer of the medium is required, the slight discoloration will not prove very objectionable. It is perhaps possible to bleach the solution somewhat. To prepare the tolu for use it should be dissolved in either alcohol or chloroform (the latter is preferable for many reasons) and then well filtered. It will not dissolve in benzole. By a gentle heat the solvent can then be evaporated so as to leave the solution in any desired state of concentration.

The ordinary gum benzoin (or benjamin) is quite as good as styrax, if not better, but neither is so good as tolu. The gum benzoin should be prepared as directed for tolu.

Biniodide of Mercury and Iodide of Potassium and Phosphorus for Mounting.†—Mr. Kain also drops "a word or two of caution in regard to the use of the solution of biniodide of mercury and iodide of potassium as a mounting medium. On account of its great density and high refractive index it is valuable for many purposes, but immersion objectives should be used on such mounts with great caution. Even after the glass cover has been apparently thoroughly washed, enough of the mercurial solution often adheres to cause quite a deposit of mercury to accumulate on the front brasswork of the

* Micr. Bulletin, i. (1884) p. 36.
† Ibid., pp. 36-7.

objective. The writer came near ruining a valuable objective in this way. The solution is also a violent poison, and if the slightest drop touches a tender portion of the skin, as the lips for instance, it burns like fire, and leaves a bad blister.

Phosphorus mounts, too, are fraught with considerable danger. The beautiful slides of Möller mounted in this medium are evidently prepared with great care, but after a time the medium either acts upon the asphalt ring or penetrates it, so that the smell of phosphorus is plainly discernible, and in the dark the ring is luminous. A correspondent states that he had a bad fire in his cabinet from the spontaneous combustion of one of these mounts. For those who possess valuable cabinets it will be at least a wise precaution to avoid placing phosphorus mounts with their other slides. They should be kept in a cool, dark place, and in such a locality that other property will not be jeopardized if spontaneous combustion should ensue. Notwithstanding its very high index of refraction, it is not likely that phosphorus will ever become a general favourite as a mounting medium, partly on account of the danger in manipulating it, and partly because the preparations lack permanence, for even when carefully kept away from the light they deteriorate in the course of time."*

The statement of the correspondent as to the "bad fire" in his cabinet through the combustion of a phosphorus-mounted slide is, we fear, a little imaginative, or at least exaggerated, having regard to the very small quantity of phosphorus in a mount.

Chapman's Slide Centerer.†—This is a device of Mr. A. B. Chapman for mounting objects accurately in the centre of the glass slip, and for applying the thin cover-glass concentrically with the object. It has two revolving backgrounds to contrast with the colour of the object, one being black with white circles, the other white with black circles, and so arranged that, by simply turning a little knob, either can be used or both removed as desired without touching the slip, which can be finished entirely (except the ringing) before it is taken off the instrument. It is so simple that there is nothing to prevent any manipulation required in mounting the object.

Indian Ink for examining Microscopic Organisms.‡—L. Errera, after some general remarks on the principles involved in mounting in media of different refractive indices and in staining,§ points out that living organisms do not absorb the various colouring solutions. The exception to this rule pointed out by Brandt ‖ and Certes ¶ are only apparent exceptions. According to Brandt, the nucleus of living Protozoa can be dyed pale violet by a dilute solution of hæmatoxylin, and the fatty granules can be dyed brown by Bismarck brown.

* As to this, see this Journal, *ante*, p. 475.

† Sci.-Gossip, 1884, p. 260.

‡ Bull. Soc. Belg. Micr., x. (1884) pp. 184–8.

§ "In visiting the laboratories of microscopists one might often believe oneself to be in a dyer's workshop."

‖ See this Journal, i. (1881) p. 956.

¶ Ibid., pp. 527 and 694.

Certes found this last action also with cyanin or quinolein blue. But in all these experiments the protoplasm, properly so called, remains colourless, and the coloured solution always exercises an injurious action on the vitality of the organisms; so that it can only be used in an extremely dilute condition and for a very short time.

If, on the contrary, we try the converse method and place the living organisms in a somewhat strong coloured solution they are likely to die, either by exosmosis or more often by actual poisoning.

It will therefore be useful to have a deeply coloured liquid which is not poisonous, and which does not exercise any sensible osmotic action on microscopic beings placed in it. To satisfy these conditions it is sufficient to substitute for the coloured solutions water holding in suspension coloured insoluble powder. Indian ink, on account of its harmless nature and its deep colour, is very fit for this purpose. It consists, as is well known, of lampblack and a gummy substance, very slightly perfumed with musk or camphor. On powdering it into water a very black liquid is obtained, owing to the fine particles of carbon held in suspension; it does not cause the plasmolysis of the cells, and the organisms continue to live perfectly in it.

The process of using it is as follows:—A little indian ink, not too much perfumed, is rubbed up in a porcelain saucer. It is important to triturate it carefully. The liquid should show, under the Microscope, excessively small granules of equal size, having a lively Brownian movement; it ought to have, when in very thin layers, a dark grey, but not an opaque black tint. A drop of this liquid is placed on a slide, the organisms to be examined are placed upon a cover-glass, and this is applied to the drop. In this way black particles between the cover-glass and the objects are avoided. The objects appear remarkably illuminated on the grey-black ground, so that their details can be seen distinctly. The carbonaceous matter does not seem to affect the organisms; they bear it very well, and the author has been able thus to preserve *Spirogyra*, *Vaucheria*, Infusoria, &c., for several days alive.

For prolonged observations it is of course advisable to use a moist chamber, or to prevent evaporation by placing the preparation in an atmosphere saturated with aqueous vapour.

Permanent preparations can also be made. To do this, the indian ink, in water, is gradually replaced under the cover-glass by indian ink in glycerin. Care must be taken that the black liquid does not pass the edges of the cover, otherwise currents will be produced in consequence of the evaporation, and the black particles will no longer be uniformly distributed.

Indian ink will, it seems to the author, render great service in showing the gelatinous envelopes of the lower organisms, and the gelatinized layers of the membranes of the higher plants. The gelatinous envelopes of many filamentous algæ, of *Glœocapsa*, of the colonies of zoogloœa, &c., are with difficulty distinguishable in water, but nothing, on the contrary, is so easy when the observation is made in water charged with indian ink. The method might probably also,

it is suggested, be applied advantageously in the study of the digestion of the Infusoria, of the movement of diatoms and ciliated organisms, &c.

Apparatus for Aerating Aquaria.*—Different forms of apparatus are used in laboratories for supplying air to plants and animals kept for observation in aquaria. These, P. Francotte thinks, are all rather complicated, and he has therefore constructed two very simple models, which he has successfully employed.

Make a loop at 30 cm. from one of the extremities of a glass tube of from 5 to 7 cm. diameter and 1 m. long. To do this heat the tube and bend it on itself, the tube thus being divided into two unequal portions.

At 7 or 8 cm. from the loop, and in the shorter part of the tube, heat a small point by the blow-pipe. The heated glass forms a little bead, and whilst this is very hot draw it out (by a piece of tubing) into a little capillary tube, and bend it if possible at a right angle at a distance of 1 cm. from its point of origin, at the same time breaking off the end. The tube, thus prepared, is put in communication with a vessel of some litres' capacity, placed at a height of from 1 m. to 1·50 m. This can be done by a piece of indiarubber tubing and a siphon, the short arm of which is immersed in the vessel. By sucking the lower end of the tube, the latter will be filled with water. The liquid column will play the part of a piston in a pump; the air will be drawn through the opening of the capillary tube, and a number of little columns of water will be produced containing between them bubbles of air.

To regulate the flow of water and insure the air being supplied in proportion to the liquid used, the indiarubber tube should be compressed by a clip, and the apparatus made to work as slowly as possible, so that the air-bubbles drawn in can be easily counted. The lower extremity of the tube is plunged in the aquarium, where the air causes a bubbling and movement in the water.

Dr. Fol recently suggested † saturating with carbonic acid the sea-water containing Medusæ, star-fishes, &c., in order to render them motionless. This can be best accomplished by a modification of the above apparatus. In place of drawing out a capillary tube, a tube of the same diameter as the principal tube is soldered at right angles to it and slightly bent. The branch tube is then by an indiarubber tube placed in communication with the apparatus containing the gas, ether, &c.

Detection of Sewage Contamination by the use of the Microscope, and on the Purifying Action of minute Animals and Plants.‡—Dr. H. C. Sorby writes: "By studying with the Microscope the solid matters deposited from the waters of a river, the previous contamination with sewage can usually be detected without any considerable difficulty. If the amount be serious, the characteristic particles of

* Bull Soc. Belg. Micr., x. (1884) pp. 141–3.
† See this Journal, iii. (1883) p. 137.
‡ Journ. Soc. Arts, xxxii. (1884) pp. 929–30.

human excrement can easily be seen; and if it is small, and has been carried a long way by the current, it can usually be recognized by means of the hairs of oats derived mainly from the droppings of horses, which resist decomposition for a long time, and are not consumed as food by minute animals. I, however, do not propose to enter into detail in connection with this part of my subject, but specially desire to call attention to the connection between the number of minute animals and plants, and the character of the water in which they live, and also to their influence in removing organic impurities.

For some time past I have been carefully ascertaining the number per gallon, of different samples of river and sea water, of the various small animals which are large enough not to pass through a sieve, the meshes of which are about 1/200 part of an inch in diameter. The amount of water used varies from ten gallons downwards, according to the number present. By the arrangements used there is no important difficulty in carrying out the whole method in a satisfactory manner. I confine my remarks entirely to general mean results.

The chief animals met with in fresh water are various entomostraca, rotifera, and the worm-like larvæ of insects. I find that the number per gallon and percentage relationships of these mark, in a most clear manner, changed conditions in the water, the discharge of a certain amount of sewage being indicated by an increase in the total number per gallon, or by an alteration in the relative numbers of the different kinds, or by both. All my remarks apply to the warm part of the year, and not to winter.

It is known that entomostraca will eat dead animal matter, though probably not entirely dependent on it. I have myself proved that they may be kept alive for many months by feeding them on human excrement, though they soon died without it. If the amount of food in any water is small, not many of such animals can obtain sufficient; but if it be abundant, they may multiply rapidly, since it is asserted that in one season a single female *Cyclops* may give rise to no less than four thousand millions of young. In stagnant muddy ponds, where food abounds, I have found an average of 200 per gallon. In the case of fairly pure rivers the total number of free-swimming animals is not more than one per gallon. I, however, found that where what may be called sewage was discharged into such water the number per gallon rose to twenty-seven, and the percentage relationships between the different groups of entomostraca were greatly changed. In the Thames at Crossness, at low water, the number was about six per gallon, which fell to three or four at Erith, and was reduced to less than one at Greenhithe.

There is, however, a very decided limit to the increase of entomostraca when the water of a river is rendered very impure by the discharge of too much sewage, probably because oxygen is deficient, and free sulphide of hydrogen present. Such water is often characterized by the great number of worm-like larvæ of insects. Thus, in the Don, below Sheffield, in summer, I found the number per gallon, of entomostraca only about one-third of what it is in pure waters;

whilst, on the contrary, the number of worm-like larvæ were more than one per gallon.

Now if the minute free-swimming animals thus increase when a certain amount of sewage supplies them with ample food, it is quite obvious that they must have a most important influence in removing objectionable impurities. The number of excrements of entomostraca in the recent mud of such rivers as the Thames is most surprising. In one specimen from Hammersmith, I found that there were more than 20,000 per grain; and the average number at Erith in August, 1882, was above 7000, which is equivalent to about 200,000 per gallon of water at half-ebb, from the surface to the bottom. This enormous number must represent a very large amount of sewage material consumed as food; and though, as in the case of larger animals, a considerable part of their excrements no doubt consists of organic matter capable of putrefaction, yet there can be no less doubt that the amount entirely consumed in the life-processes of the animals is also great.

As named above, I kept *Cyclops* alive for many months by feeding them on human excrement. It is thus easy to understand why, when they abound in the Thames, the relative amount of human excrement is very considerably less than in the winter, when their number must be much smaller.

We thus appear to be led to the conclusion that when the amount of sewage discharged into a river is not too great, it furnishes food for a vast number of animals, which perform a most important part in removing it. On the contrary, if the discharge be too great, it may be injurious to them, and this process of purification may cease. Possibly this explains why in certain cases a river which is usually unobjectionable may occasionally become offensive. It also seems to make it clear that the discharge of rather too much sewage may produce relatively very great and objectionable results.

Though such comparatively large animals as entomostraca may remove much putrefiable matter from a river, we cannot suppose that, except incidentally, they remove such very minute objects as disease germs, but it would be a subject well worthy of investigation to ascertain whether the more minute infusoria can, and do consume such germs as a portion of their food. If so, we should be able to understand how living bodies, which could resist any purely chemical action likely to be met with in a river, could be destroyed by the digestive process of minute animals. Hitherto I have had no opportunity for examining this question critically, but have been able to learn certain facts which, at all events, show that it is well worthy of further examination. It is only during the last month that I have paid special attention to the number of the larger infusoria, and various other animals of similar type, met with per gallon in the waters of rivers and the sea, which can be seen and counted by means of a low magnifying power. At low water in the Medway above Chatham, in the first half of June, the average number per gallon has been about 7000, but sometimes as many as 16,000. Their average size was about 1/1000 in. Possibly the number of still more

minute forms may be equally great; but, even if we confine our attention to those observed, we cannot but conclude that their effect in removing organic matter must be very considerable; and judging from what occurs in the case of larger animals, those 1/1000 of an inch in diameter may well be supposed to consume as food, particles of the size of germs. Up to the present time, I have, however, collected so few facts bearing on this question, that it must be regarded merely as a suggestion for future inquiry.

So far, I have referred exclusively to the effect of animal life. Minute plants play an important part in another way. The number per gallon of suspended diatoms, desmids, and confervoid algæ is, in some cases, most astonishing, and they must often produce much more effect than the larger plants. As far as I have been able to ascertain, their number is to some extent related to the amount of material in the water suitable for their assimilation and growth. In the mud deposited from pure rivers their number is relatively small, but in the district of the Thames, where the sewage is discharged, I found that in summer their number per grain of mud at half-ebb tide was about 400,000, which is equivalent to above 5,000,000 per gallon of water. This is two or three times as many as higher up or lower down the river, and, out of all proportion, more than in the case of fairly pure rivers like the Medway. Their effect in oxygenating the water must be very important, since, when exposed to the light, they would decompose carbonic acid and give off oxygen, under circumstances most favourable for supplying the needs of animal life, and counteracting the putrefactive decomposition so soon set up by minute fungi when oxygen is absent.

Taking then, all the above facts into consideration, it appears to me that the removal of impurities from rivers is more a biological than a chemical question; and that in all discussions of the subject, it is most important to consider the action of minute animals and plants, which may be looked upon as being indirectly most powerful chemical reagents."

Examination of Handwriting.* — Dr. G. E. Fell records a curious case in which the Microscope was applied by himself and Prof. D. S. Kellicott to the detection of the manipulation of a written document.

At first sight the document looked as if it was all written with one kind of ink—a heavy black ink. Closer examination with a Microscope, however, showed that the original writing was in a pale yellow ink, and that this had afterwards been traced over with the black ink. Further examination showed that the last clause, "And Colby's bond is hereby cancelled," had been originally written with ink of a brownish tinge. The document was held by the judge, before whom the case came, to be spurious, the inference being that the words quoted above had been added after it was signed, and that then the whole was traced over in order to make the entire document appear to have been written at one time and with the same ink.

* Proc. Amer. Soc. Micr., 7th Ann. Meeting, 1884, pp. 47–58.

The Microscope in Palæontology.*—Dr. M. Poignand briefly sketches the use of the Microscope in palæontology generally, and notices a few well-known instances in more detail. These include bones, teeth, scales and carapaces, shells, corals, sponges, plants, &c. The paper is accompanied by a plate illustrating the structure of the teeth of *Megatherium* and the sloth.

Adams, J. M.—Easy Method of staining Bacteria.

["Dissolve anilin violet, blue, or brown in glycerin, with or without alcohol or carbolic acid. Prepare thin covers by dropping with pipette a drop of bacterial fluid on each, and allowing it to dry thoroughly. Cover the dry bacterial film with a drop of the staining, and let it remain an hour, or long enough to stain deeply. Put a drop of water on centre of slide, and invert the cover on it ready for mounting, letting it sway slightly to and fro to wash away a part of the surplus staining and glycerin, but not to remove the film. Press down the cover with a blotter, which will absorb the surplus, and ring quickly. The glycerin being washed away in part does not materially dim the bacteria or affect the anilin, and it is surprising how distinctly visible all kinds of bacilli, spirilla, and some of the bacteria and micrococci appear by this process.

One pleasant advantage is the freedom from sediment, as is apt to occur with other methods of staining, and the ease with which the depth of colouring may be regulated, as well as the reliable work for time being."]

The Microscope, IV. (1884) pp. 224–5.

Analysis, the Microscope in. [*Post.*]

Sci. Monthly, II. (1884) p. 187, from *New York Independent Record.*

Aylward's (H. P.) Telescope Walking-stick to use with his Pond-life Apparatus.

Journ. of Microscopy, III. (1884).

Barrett, J. W.—New method of cutting sections for microscopical examination. [*Post.*]

Journ. Anat. and Physiol., XIX. (1884).

Caldwell's Automatic Microtome. [*Post.*]

Quart. Journ. Micr. Sci., XXIV. (1884) pp. 648–54 (1 pl.).

Chapman's (A. B.) Microscopic Slide Centerer. [*Supra*, p. 986.]

Sci.-Gossip, 1884, p. 260.

Dimmock's (G.) Method of cataloguing and arranging slides. [*Post.*]

Sci. Record, II. (1884) pp. 185–6.

Doherty, A. J.—On Injecting.

[Methods. Formulæ. The Syringe. Killing the animal. Injecting a whole animal. Hardening injected tissues. Injecting separate parts.]

Micr. News, IV. (1884) pp. 268–75.

Elsner, F.—Mikroskopischer Atlas (Microscopical Atlas). Part II., 8 pp. and 2 pls. of 29 photo-micrographs; Part III., 9 pp. and 2 pls. of 33 photo-micrographs; Part IV., 8 pp. and 2 pls. of 30 photo-micrographs.

[Contains Cocoa, Cinnamon, Cloves, All-spice, Capsicum, Nutmeg, Mace, Pepper, Saffron, Cardamom, and Adulterants.]

4to, Halle a. S., 1884.

English's (H.) Typical Series of Vegetable Fibres.

[Mounted in a mixture of glycerin and water, which is thought to be the best medium for the purpose.]

Amer. Mon. Micr. Journ., V. (1884) p. 200.

Fell, G. E.—Examination of Agreement, Exhibit "B." The People v. Colby. [*Supra*, p. 991.] *Proc. 7th Ann. Meeting Amer. Soc. Micr.*, 1884, pp. 47–58.

The Microscope, IV. (1884) pp. 207–8.

Freud, S.—Eine neue Methode zum Studium des Faserverlaufs im Centralnervensystem. (A new method of studying the central nerve-system.) [*Post.*]

Arch. f. Anat. u. Physiol., 1884 (*Anat. Abtheil.*) pp. 453–60.

---

* Journ. of Microscopy, iii. (1884) pp. 163–70 (1 pl.).

GARBINI, A.—Manuale per la Tecnica moderna del Microscopio nelle Osservazioni zoologiche, istologiche ed anatomiche. (Manual of the modern technic of the Microscope in zoological, histological and anatomical observations.)
16mo, Verona, 1884.

GRAVIS, A.—Microscopical Technique at Naples in 1883.
[Translated and adapted by J. S. Kingsley from the French in Bull. Soc. Belg. Micr., *ante*, p. 483.]
Sci. Record, II. (1884) pp. 198–203, 227–31.

GRIFFIN, A. W.—On the collection and preparation of the Diatomaceæ. II. Preparation. *Journ. of Microscopy*, III. (1884) pp. 229–36.

HOFMEISTER, V.—See Bibliography *a*.

JAMES, F. L.—Method of preparing picro-carmine and indigo-carmine. [*Supra*, p. 982.]
Amer. Mon. Micr. Journ., V. (1884) pp. 178–9, 199, from *National Druggist*.

JIJIMA, J.—Entwickelungsgeschichte der Süsswasser-Dendrocœlen. (Development of Fresh-water Dendrocœla.)
[Contains methods of preparing Planarians and their Eggs. Abstr. in Amer. Natural., xviii. (1884) pp. 1068–9, *ante*, p. 746, and *supra*, p. 978.]
Zeitschr. f. Wiss. Zool., XL. (1884) pp. 359–464 (4 pls.).

KAIN, C. H.—Mounting Media. [*Supra*, p. 985.]
Micr. Bulletin, I. (1884) pp. 36–7.
Journ. of Microscopy, III. (1884) p. 259.

KINGSLEY, J. S.—Microscopical Methods. IV. Imbedding.
Sci. Record, II. (1884) pp. 172–6 (1 fig.).
" " Rapid Imbedding. [*Post.*] *Sci. Record*, II. (1884) p. 269.
" " Glycerine Mounts. [*Post.*] " " pp. 269–70.

LENDENFELD, R. v.—On the Preservation of tender Marine Animals.
[Summary of the methods usually employed.]
Proc. Linn. Soc. N. S. Wales, IX. (1884) pp. 256–8.

LEWIS, W. J.—Hair, microscopically examined and medico-legally considered. [*Post.*] *Amer. Mon. Micr. Journ.*, V. (1884) pp. 162–6.
The Microscope, IV. (1884) pp. 197–201.
Also under the title of "The Microscope in Forensic Medicine."
Sci. Monthly, II. (1884) pp. 227–8.

LIBBEY, W., jun.—Celloidine as an Embedding Mass.
[Similar directions to those given *ante*, p. 822.]
Amer. Mon. Micr. Journ., V. (1884) p. 183.

M'MURRICH, J. P.—Killing Infusoria. [*Ante*, p. 813.]
Amer. Natural., XVIII. (1884) p. 832.

OSBORNE, H. F.—Upon a Microscopical method of studying the Amphibian Brain. [*Supra*, p. 978.] *Amer. Mon. Micr. Journ.*, V. (1884) p. 188.
Science, IV. (1884) p. 343.

PEYER, A.—Die Microscopie am Krankenbette. (Microscopy at the sick-bed.)
[Contains coloured plates of the appearance, under the Microscope, of urine (63), sputum (14), and fæces (2) in disease.]
8vo, Basel, 1884, xii. and 19 pp. and 79 pls. with explanations.

PIPER, R. U.—Identification of Blood-corpuscles.
[Table of the measurement of blood-corpuscles from 13 young dogs selected out of like tables of measurement of more than 400 dogs.]
The Microscope, IV. (1884) pp. 219–22.

PLAUT, H.—Färbungs-Methoden zum Nachweiss der fäulniss-erregenden und pathogenen Mikroorganismen. (Staining methods for demonstrating the putrefactive and pathogenic micro-organisms.) [*Post.*]
fol. Leipzig, 1884.

Pond Life, Collecting. [*Post.*] *Amer. Mon. Micr. Journ.*, V. (1884) p. 200.

RIEDE, A.—Mikro-photographischer Atlas für Brennereien. (Micro-photographic atlas for distilleries.) Heft 1. fol. Halle, 1884, 1 p., 4 figs., and 2 pls.

ROGERS, W. A.—A new form of Section-cutter. [*Post.*]
Amer. Mon. Micr. Journ., V. (1884) p. 171.
The Microscope, IV. (1884) p. 205.

Ryder, J. A.—On the preservation of embryonic materials and small organisms, together with hints upon embedding and mounting sections serially.
Ann. Rep. U. S. Fish Commission for 1882.
Sci. Rec., II. p. 253.

„ „ On some points in Microtomy. [*Supra*, p. 978.]
Amer. Mon. Micr. Journ., V. (1884) pp. 190–1.

Siedamgrotzky, O.—See Bibliography α.

Slack, H. J.—Pleasant Hours with the Microscope.
[Difficulties of interpretation. (Teasdale's test slides.)]
Knowledge, VI. (1884) pp. 270–1 (1 fig.).
„ „ [Mouth Organs of Diptera.] „ „ pp. 312–3 (5 figs.).
„ „ ["Daddy-Longlegs."] „ „ pp. 396–8 (4 figs.).

Smith, T.—Remarks on fluid and gelatinous media for cultivating micro-organisms, with description of Salmon's new culture-tube and demonstration of the process of using it. [*Post.*]
Amer. Mon. Micr. Journ., V. (1884) pp. 185–7.

„ „ Method of demonstrating the presence of the Tubercle Bacillus in Sputum.
[Summary of Koch's account of his original method, as modified by Ehrlich and Weigert, from MT. K. Gesundheitsamt, II., Berlin, 1884.]
Amer. Mon. Micr. Journ., V. (1884) pp. 196–9.
from *Medical Annals.*

Sternberg, G. M.—Methods of cultivating Micro-organisms.
[Practical demonstration of the advantages of his method—described in Rep. Amer. Assoc. Adv. Sci. for 1881—over others.]
Amer. Mon. Micr. Journ., V. (1884) pp. 183–5.

Taylor, T.—Microscopic Observations. Internal Parasites in Domestic Fowls, and Butter and Fats. [*Post.*] 8vo, Washington, 1884, 7 pp. and 1 pl.

Technique, Microscopic, recent advances in. *Science*, IV. (1884) pp. 350–1, 365.

Truan y Luard, A.—Ensayo sobra la Sinopsis de las Diatomeas de Asturias.
[Contains directions for collecting and mounting diatoms.]
An. Soc. Españ. Hist. Nat., XIII. (1884) pp. 307–52 (4 pls.) in part.

Tschirch.—Ueber mikroskopische Stärkemehluntersuchungen. (On the microscopical examination of Starch.) [*Post.*] *Bot. Centralbl.*, XX. (1884) p. 122.

Virchow, H.—Ueber die Einwirkung des Lichtes auf Gemische von Chromsauren Salzen (resp. Chromsäure), Alkohol und extrahirten organischen Substanzen. Technische Mittheilung. (On the action of light on mixtures of chromates (chromic acid), alcohol, and extracted organic substances. Technical communication.) [*Post.*]
Arch. f. Mikr. Anat., XXIV. (1884) pp. 117–9.

Voigt, W.
[Contains a method of isolating the jaws of *Branchiobdella*. [*Post.*]
Semper's Arbeit., VII. (1884) pp. 47 and 54–5.

Vries, H. de.—Handleiding bij het vervaardigen van microscopische Praeparaten uit het Plantenrijk, voor eerstbeginnenden. (Instruction in the making of microscopical preparations from the vegetable kingdom for beginners.)
[Part I. General rules for making and examining microscopical preparations. Part II. Cells. Part III. Tissues. Part IV. Reproductive organs of Phanerogams. Part V. Cryptogams.]
8vo, Zaltbommel, 1884, x. and 97 pp.

West, T.—*Bugula avicularia.*
[May be mounted with the polypus fully expanded by *dropping* gin carefully and slowly into a small vessel containing the specimen in sea water, observing to do so when they are *fully expanded*. This intoxicates them; they die in their extruded condition, and can be removed and mounted.]
Journ. of Microscopy, III. (1884) pp. 248–9.

Wythe, J. H.—Remarks on Microscopic Graphiology.
[Discussion on his paper published, I. (1881) p. 859.]
Journ. Quek. Micr. Club, II. (1884) pp. 86–90.

PROCEEDINGS OF THE SOCIETY.

Meeting of 8th October, 1884, at King's College, Strand, W.C., the President (the Rev. W. H. Dallinger, F.R.S.) in the Chair.

The Minutes of the meeting of 11th June last were read and confirmed, and were signed by the President.

Mr. Crisp said that the first matter upon the Agenda was the Report of the Deputation who were appointed to represent the Society at the meetings of the American Society of Microscopists and the American Association for the Advancement of Science. The President would present that Report, but before he did so, he (Mr. Crisp) would read the reference to the subject which had been printed by anticipation in the October number of the Journal (see p. 808).

The President said it now fell to him to report upon the visit which he had paid on their behalf since their last meeting, in company with Mr. Bennett (Mr. Glaisher being unfortunately prevented from attending), and he might say at the outset that the visit was of considerable interest. After some days spent in New York, during which he endeavoured to obtain as much information as was possible with regard to American microscopy generally, they made their way to Rochester, N.Y., where the annual meeting of the American Society of Microscopists was to be held. The inaugural address by Dr. J. D. Cox, the President of the Society, was chiefly devoted to an account of the work of Tolles, particularly as regarded the production of the lenses of large aperture for which his name was famous. At the subsequent meetings subjects of a very practical character were brought forward and discussed, and a great deal of enthusiasm was shown, especially by the younger men present, amongst whom he was glad to find there were many who were devoting themselves to the study of micro-organisms and pathogenic forms. The discussions also were carried on with great spirit. The factory of the Bausch & Lomb Optical Co. (situated in the town of Rochester) was thrown open to the inspection of all the visitors, and the firm spared no pains to make everything as interesting as possible. They were taken through all the departments, and shown all the processes of manufacture of Microscopes and apparatus by machinery which it was said produced the various parts with such accuracy that they would perfectly fit any instrument of the class to which they belonged. On the same evening a handsome repast was served in a tent, tastefully arranged and lighted by electricity. Great good feeling was displayed, healths were drunk, and prosperity to the Royal Microscopical Society was one of the toasts of the evening. At the conversazione there was a large display of Microscopes and objects, and though there was nothing specially new exhibited, the general arrangements were so well carried out that the gathering was

one of the best of its kind that he had ever attended. Generally, the meeting must be considered as a most successful one, and as regarded themselves (the Deputation), he could only say that were received not only with the greatest cordiality but even with the greatest deference, doubtless from the circumstance that they were there as the representatives of a Society whose position was considered to entitle it to every mark of respect. In addition to the great kindness everywhere experienced, the friends at Rochester took a further opportunity of showing their generosity, and of treating him not merely as a visitor but as their guest, for though he went to an hotel on his own account, he found on leaving that his bill had been paid. The feeling he left behind was one of a most pleasant description. He had formed some new friendships, and had made the acquaintance of much to be remembered with pleasure.

The President then referred to his visit to the meeting of the American Association for the Advancement of Science at Philadelphia, which he also attended in the character of a Deputation from the Society, and here also he experienced the utmost cordiality from all with whom he came in contact.

Dr. Anthony said that it gave him great pleasure after hearing the account which the President had given them, to propose on behalf of the Society that its warmest thanks be given to the American Society of Microscopists for the very cordial, generous, and hospitable reception which they had given to the representatives of the Society on the occasion of their recent visit to the Annual Meeting at Rochester. He had himself fully expected that a Deputation from this Society would meet with a hearty welcome, and he was sure that all would be glad to hear how thoroughly these anticipations had been realized. It had not unnaturally been regarded as an evidence of very friendly feeling that a Society like theirs should send its representatives to express an interest in what was being done across the water; long might it be the case that the people who formed that great nation would remember with affection the old country from which they sprang.

Dr. Braithwaite seconded the motion.

Mr. Beck said it was no matter of surprise to him that the Deputation should have so pleasant a report to give of their visit to the American microscopists, because he knew from personal experience, how pleased they were to receive even a humble microscopist like himself. He knew also that it could not but be pleasant to their friends to receive an acknowledgment of their welcome, and he was therefore very glad that Dr. Anthony had proposed the vote of thanks in the way he had done. He hoped that from year to year, any of their Fellows who crossed the Atlantic would bear with them some proofs of their connection with the Society which would be found to be an "open sesame" to the goodwill of their fellow workers over there. Though they were still young as a country, and though some of their researches were behind those of the old world, yet there was an earnest striving after scientific knowledge for its own sake which would before long make them an important factor in connection with

the progress of research into those numerous questions which were destined to engage attention in the future. It might not be out of place to mention that the American Government was so well aware of the value of the Microscope that one was included in the outfit of every officer appointed to a distant station, not for medical purposes, but so that, having a large amount of time upon his hands, he might be able to collect valuable information as to the objects by which he found himself to be surrounded.

Mr. A. W. Bennett said he should like to be allowed to say a few words also as to the very great kindness and hospitality with which they were received at Rochester. He could of course well understand that one so distinguished in scientific research as their President should be received with special marks of distinction; but when they found that a similar reception was also extended to a humble member of the Society like himself they might well consider it as a proof of the high regard in which their Society was held. He might add that after their President had been compelled to leave, he (Mr. Bennett) took an opportunity of publicly thanking the American Society for what they had done; and he should like to mention that he was assured that the visit of their President had had no little effect in stimulating the love of the advancement of science amongst the members.

The President having put the motion to the meeting declared it carried by acclamation.

Mr. J. Mayall, jun., thought that it would doubtless be agreeable to the meeting if their thanks were also extended to the American Association for the Advancement of Science, and he had great pleasure in moving accordingly.

Mr. Cheshire having seconded the motion,

The President put it to the meeting and declared it to be carried unanimously.

Mr. Crisp said that before they left this subject he might refer to the lustre which had been reflected upon the Society by their President during the meeting of the British Association at Montreal, more particularly in connection with the lecture which he delivered "On the lowest and smallest forms of life as revealed by the modern Microscope" (see p. 721). The public press, both here and on the other side, had been especially complimentary to the President in regard to this lecture.

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
Hon. Mrs. Ward.—The Microscope. vi. and 154 pp., 25 figs. and 8 pls. 3rd. ed. 8vo, London, 1869.	*Mr. Crisp.*

Mr. Crisp called the attention of the meeting to the fact of the death of one of their most distinguished Honorary Fellows, Dr. J. J. Woodward, and read an obituary notice of him from the 'Times.'

The President was sure that all would feel sincere regret that the

Microscope had lost so efficient and earnest a worker, one who had not only done excellent work himself, but who had set going a great many other workers in the same direction. Dr. Woodward had in addition to his microscopic studies worked very hard in his department until some time ago having met with a serious accident, he showed some signs of paralysis. Just about that time President Garfield required his services and the great strain and anxiety thus placed upon him proved too much for him in his state of health.

Dr. Maddox said perhaps he might be allowed to say a kindly word concerning one whose friendship he had valued highly, and with whom he had corresponded for many years upon those subjects which had rendered his name famous in the history of photo-micrography. He used to write so freely upon matters of mutual interest and explained his methods and processes of manipulation so fully, and always with so much courtesy, that he felt that he had indeed lost a friend, and he wished to take the opportunity of recording the respect in which he held the memory of one to whom he had so largely been indebted.

Mr. Beck did not like to let the opportunity pass of making the suggestion that steps should be taken to secure a good obituary notice of Dr. Woodward in their next annual report. The notice read by the Secretary was, he believed, the one which appeared in the 'Times' newspaper, which, though good as far as it went, yet could not, in that brief compass, give an idea of the genial character of the man, and his high personal qualities. He had known him for thirteen years, and whenever during that period he went to Washington there was always a warm welcome and every assistance which he required. Though Dr. Woodward's labours were very great at the Army and Navy Museum, he found time to carry out a large number of researches, the results of which they had so often seen. He had the advantage of working under a liberal Government, who provided him with apparatus suited to his requirements, and he thus possessed a magnificent collection of object-glasses which he knew well how to use, as the beauty of his photographs abundantly testified. These photographs he took a pleasure in showing and he had an ingenious contrivance at the museum for enabling the public to see them.*

* Since the meeting the following obituary notice of Dr. Woodward has been received.

"War Department, Surgeon-General's Office,
Washington, D.C., August 20, 1884.

In announcing to the Officers of the Medical Department the death of Joseph Janvier Woodward, Surgeon and Brevet Lieutenant-Colonel, U.S. Army, which occurred near Philadelphia, Pa., August 17, 1884, the Surgeon-General wishes to offer his tribute of respect to the memory of the deceased, whose distinguished career and valuable services, for a period of twenty-three years, have shed lustre on the corps, and for whose untimely loss feelings of profound regret will be shared alike by his comrades in arms and by the profession at large.

Dr. Woodward was born in Philadelphia, Pa., October 30, 1833, and was educated at the Central High School of that city, graduating with honour as Bachelor of Arts in 1850, and receiving the degree of Master of Arts from the same institution in 1855.

He graduated in medicine at the University of Pennsylvania, April 1853;

Mr. Conrad Beck exhibited and described a new form of portable Microscope in which the Jackson-Lister form of stand was retained.

Mr. J. Mayall, jun., exhibited a Microscope having a modified form of rack and pinion adjustment, in which what was known as the "stepped-rack" principle had been adopted (see p. 958). It consisted in making use of a triple rack with three pinions on one axis, which gave a remarkable degree of smoothness of motion without the slightest tendency to slip. This form of rack was used on a large scale in the beds of

---

entered the army as assistant-surgeon, August 5, 1861; became captain and assistant-surgeon, July 28, 1866; major and surgeon, June 26, 1876. "For faithful and meritorious services during the war" he received the brevets of captain, major, and lieutenant-colonel, U.S. Army.

He was assigned to duty in this Office May 19, 1862, and from that date until the beginning of the illness which terminated in his death was intimately identified with its professional and scientific work.

While the valuable results of his life's labour are comprehended in a long list of miscellaneous publications, both professional and scientific, too familiar to the corps to require individual mention, his greatest triumphs were won in the field of microscopical investigation in normal and pathological histology, and in his happy application of photo-micrography to the purposes of science. In these pursuits he attained remarkable success, and achieved an enviable, world-wide reputation, leaving to science and medicine lessons of undoubted value and usefulness. Of his strictly professional work, the medical portion of the 'Medical and Surgical History of the War of the Rebellion' was the crowning achievement. In the second part of this work he developed the results of his careful investigations into the nature and pathology of the intestinal diseases which had proved so fatal in the late war. Here also he displayed his wonderful capacity for that minute and exhaustive research which forms so striking a feature of his writings.

As in the case of his co-labourer, Otis, he yields to other hands the honour of completing his labours.

In addition to his engrossing professional duties, his restless activity of mind led him to seek recreation in his favourite studies, physics, art, and philosophy.

Endowed with a retentive memory and of untiring industry, he acquired a vast store of information, which he held available for use at will; fluent of speech, he took delight in the expression of his views and opinions both in social converse and in the arena of scientific debate.

His fund of knowledge, his strong convictions, his tenacity of opinion, and his quick perception made him a controversialist of no low order.

With such a record, it is needless to speak of his zeal, his ambition, or his devotion to his profession, and especially to the reputation of the corps of which he was so bright an ornament.

Of a sensitive, highly strung, nervous organization, the confinement, anxiety, and labour to which he was subjected in his attendance upon the late President Garfield during his long illness, proved too much for a mind and body already overstrained by incessant labour, and precipitated the illness which finally terminated his life.

At the time of his death Dr. Woodward was a member and Ex-President of the American Medical Association, a member and Ex-President of the Washington Philosophical Society, a member of the National Academy of Science, of the Association for the Advancement of Science, of the Academy of Natural Sciences of Philadelphia, and of the College of Physicians and Surgeons of Philadelphia. He was an honorary member of several American and foreign scientific, medical, and microscopical societies, and the recipient of many distinguished honours from learned bodies in this country and abroad.

R. MURRAY,
Surgeon-General, U.S. Army."

powerful planing machines, to which a perfectly true motion combined with a powerful grip was an essential qualification. He also explained a new form of fine adjustment which Messrs. Swift had applied to the same instrument.

Mr. Crisp exhibited the Geneva Company's Microscope Callipers (*ante*, p. 796), an instrument for measuring very minute thicknesses up to 1/1200 mm.

Mr. J. Mayall, jun., said that Mr. A. Y. Moore had forwarded a slide of *Amphipleura pellucida* which was worth remark. It looked as if the diatoms had been burnt on the cover-glass in the usual way, and that then a coating of silver had been deposited upon them. The object gave the strongest and best image with the vertical illuminator that he had ever seen. He could not explain why it was so without further examination; but Mr. Powell had brought a Microscope for the purpose of showing it, so that the Fellows would have an opportunity of examining it for themselves.

Mr. Crisp said that the slide was no doubt mounted in the way recently published by Mr. Moore (*ante*, p. 829), viz. by coating one side with pure silver, increasing its visibility more than four times.

Mr. Mayall said he might venture to state that he had examined the slide with an objective of very large aperture and did not see the dots as described by Mr. Moore.

Prof. Bell exhibited specimens of Crustacea which had been sent by Mr. Bolton—*Leptodora* and *Argulus*—and made some remarks descriptive of the animals and their habits.

Mr. Crisp exhibited Mr. Griffith's ingenious turn-table, described (but not exhibited) at the June meeting (*ante*, p. 826).

Prof. Bell said he did not know whether it was the case that any of the Fellows of the Society had not yet been to one of the most interesting and instructive exhibitions which had been offered to their notice, but if so, he would strongly recommend them to repair the omission while the opportunity remained, and pay a visit to room No. 15 of the City and Guilds' Institute to see what Mr. Watson Cheyne had prepared in the way of Bacteria and their various modes of propagation in their proper media (see p. 808). He thought it desirable to mention the matter, because the time for the close of the exhibition was now getting short. Mr. Cheyne gave a demonstration on Thursdays at 4 o'clock. He hoped that the value of the exhibition would before long be more fully recognized, and that it might lead to the establishment of some such systematic experiments and researches as those carried on by Dr. Koch under the auspices of the German Government.

Mr. Cheshire said he was glad that Prof. Bell had drawn attention to this matter. He had recently found some specimens which were very peculiar, and which he had given to Mr. Cheyne, who was

now cultivating them. They grew in meat gelatin, and apparently commenced by constantly turning corners upon themselves so as to form nodules. When they had exhausted the gelatin surrounding them, they commenced to throw out threads in various directions, at the ends of which fresh nodules were formed. These in turn threw off other threads, but always in the direction of unexhausted gelatin, and how it was that these bacilli had this extraordinary faculty for finding out the best method of obtaining nutriment was a very curious question. The peculiarities described were drawn upon the blackboard by the speaker, who referred to the species as *Bacillus Alvii*.

Dr. Maddox thought that in speaking of the absence of this class of exhibits at the Health Exhibition, Prof. Bell had omitted to mention what was shown in the Foreign Sections, amongst which he might refer to Pasteur's and Miquel's tables, where a very complete series of objects was shown, particularly as illustrating the development of the silkworm disease. He had been in correspondence with Dr. Miquel and found that he was carrying out his experiments in a very extensive and complete manner, with as many as 500 bulbs at one time.

Prof. Bell said that his remarks referred only to the English exhibits. He did not at all intend to ignore what was shown by foreign exhibitors.

Mr. Beck said the greatest advantage of the display at the Exhibition was in the demonstrations which took place. Where such things were only shown in bottles, people passed by them and were no wiser.

The President said the subject was so extremely interesting that it was to be hoped that all who could do so would visit the laboratories. He was sorry that he had not himself yet had an opportunity of going, but he intended to do so.

Dr. Millar said he had been very much interested by what he had seen at the laboratory. Mr. Cheyne lectured before a very small audience, but those who attended could not fail to be much gratified.

Mr. J. D. Hardy exhibited and described his flat collecting bottle made of sheet glass, with thick indiarubber cemented between (see p. 977).

The President thought that all pond hunters would at once see the great advantage of having their collecting bottles of this shape, so that they would go easily into the coat pocket. The contents could also be readily examined under the Microscope. He considered it a most admirable contrivance for the purpose for which it was designed.

The following Instruments, Objects, &c., were exhibited:—

Mr. C. Beck:—Portable Microscope of Jackson-Lister form.

Prof. Bell:—*Leptodora* and *Argulus*.

Mr. T. Bolton:—*Brachionus urceolaris*.

Mr. Crisp:—(1) Geneva Co.'s Microscope Callipers; (2) Griffith's Turn-table.

Mr. J. D. Hardy:—Collecting bottle.

Mr. J. Mayall, jun.:—(1) Swift Microscope with triple "stepped-rack;" (2) Swift's patent fine adjustment; (3) *Amphipleura pellucida* coated with silver.

New Fellow:—Mr. George Thomas Bettany was elected an *Ordinary* Fellow of the Society.

Meeting of 12th November, 1884, at King's College, Strand, W.C., the President (the Rev. W. H. Dallinger, F.R.S.) in the Chair.

The Minutes of the meeting of 8th October 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
Photo-portrait of the late F. A. Nobert, with his ruling machine, enlarged by Mr. J. Mayall, jun.	*Mr. J. Mayall, jun.*

Mr. J. Mayall, jun., said that at the last meeting he had called attention to a triple "stepped-rack" fitted to a Microscope which he then exhibited. It had since been found that this arrangement was rather difficult to fit with sufficient accuracy, so that a new form with a double rack had been substituted. This was found to have the required smoothness of motion (see p. 958). The Swift Microscope, which he exhibited thus fitted, had also a modified form of the Wale's inclining limb by which Mr. Swift was able to secure the complete rotation of an ordinary form of mechanical stage, which had been seldom obtained in combination with the "Jackson" form of stand. A polarizing prism, made after the formula of Dr. Bertrand, as described *supra*, p. 965, was applied to the Microscope. He also exhibited an unmounted prism made upon the same plan, showing the peculiarity of its construction, by which a field of about 44° was obtained.

Mr. Crisp exhibited and described Fasoldt's nose-piece (*supra*, p. 959).

Prof. Bell said that he had placed on the table for exhibition a cluster of branched *Vorticellæ*, which had been sent by Mr. Bolton in the hope that some Fellow of the Society might be able to name them. They were not mentioned in Kent's Infusoria.

Dr. Maddox exhibited one of Miquel's culture slides, described *ante*, p. 815. He also referred to Dr. Miquel's method of propagating bacilli by the use of sterilized gelatinized paper, some of which he exhibited. If it was desired to obtain these organisms from the

air, the paper was supplied from a revolving drum, and the air to be examined was directed upon it by an aspirator. If rain water was to be examined the paper was shaped as a coil, and the water allowed to drop slowly upon it. He had, however, suggested to Dr. Miquel that collodion films should be used instead of paper, on account of the greater transparency and absence of structure.

The President thought that this opened up a new method of inquiry which would be likely, if properly used, to lead to some very valuable results.

Mr. Crisp exhibited and described Lord S. G. Osborne's Diatomescope (see p. 961), drawing attention to the fact that the lower lens was mounted excentrically in relation to the upper lens, which Lord S. G. Osborne regarded as an essential feature in the construction.

The Rev. Metcalfe Gray's Ether Freezing Microtome was exhibited and described (*supra*, p. 981).

Mr. H. G. A. Wright's letter was read as follows, accompaning a slide of the proboscis of the blow-fly:—

"The enclosed slide was shown at the last meeting of the Microscopical section of the Royal Society of N. S. Wales, and was of much interest to the members present.

It consists of the lobes of the proboscis of the blow-fly, mounted without pressure, in a solution of biniodide of mercury in one of iodide of potassium (both saturated solutions), and was prepared by my friend Mr. Henry Sharp, of Adelong, N. S. Wales. It shows details of the structure of the pseudo-tracheæ, which I have not seen hitherto described. The drawing (taken with the camera lucida by Mr. Sayer) shows the beautiful leaf-like processes of the endoderm, which pass through the forked openings in the chitinous rings of the pseudo-tracheæ, and point out a use for that forked arrangement, which all balsam mounts show so clearly.

These processes are not alluded to in Mr. B. T. Lowne's admirable monograph on the 'Anatomy and Physiology of the Blow-fly.'

Mr. Sharp, writing to me lately, says, 'I have several probosces of blow-flies mounted in balsam, with and without pressure, but there is nothing to be seen of the membrane in any of them; I can just see it in a glycerine mount, now that I know what to look for; but the glycerine does not make it visible like the mercury solution.'

The amplification of 1000 diameters was obtained with a Tolles homogeneous-immersion 1/10 N.A. 1·33, and a Tolles 1-in. solid orthoscopic eye-piece, both of the highest excellence. Direct illumination was used by means of Powell and Lealand's achromatic condenser."

The President said that those who looked at the drawing could not fail to be struck with it, and it would probably occur to them that if such details could be brought out by the use of biniodide of mercury and iodide of potassium, it deserved to be tried as a medium not only for diatoms, as hitherto, but for other objects.

Prof. Stewart said he was unable clearly to understand what was meant by the processes of the "endoderm" as that term was generally understood.

Mr. Michael said that in Mr. Lowne's 'Anatomy and Physiology of the Blow-fly' the term was not applied in its usual sense, but appeared to convey the same meaning as epiderm, and the author of the paper probably used it in this way.

Mr. H. Mills's letter was read as follows:—"In the April number of the Journal I notice the article on Dr. Vejdovsky's Fresh-water Sponge, *Ephydatea amphizona*. In my searches for sponge last autumn, I discovered three species with the same biserial arrangement of the birotulates, or amphidiscs. In some sections of the statoblasts *three* series are plainly manifest. These discoveries were made in the latter part of October, 1883, and announced to the Microscopical Club of this city. I send by mail small fragments of the sponges which can be made into sections by imbedding in paraffin, &c. The character of the water in which these were found may be of interest to Dr. Marshall, whose article referring to some habits of fresh-water sponge precedes that of Dr. Vejdovsky in the same journal. No. 1 was found in Bear Creek, Iowa, in a very gently flowing bend of the serpentine stream. No. 2 was found in a branch of the Calumet creek, near Chicago, where the water was apparently without motion. No. 3 was found in great abundance in the slowly running bends of Ischua Creek, forty-five miles east of Buffalo. In No. 1 the statoblasts are very scarce, owing, I think, to the immature state of the specimen when found." *

Mr. G. Massee's paper "Description and Life-history of a New Fungus, *Milowia nivea*" was read (see p. 841).

Mr. Bennett said that it was necessarily rather difficult to follow a paper of that kind, which dealt so largely with hypotheses, without reading it carefully when printed, but from what he had heard it seemed to him that some of Mr. Massee's conclusions were not a little startling. All the evidence, that he was aware of, seemed rather to show that it was impossible to draw a hard and fast line between sexual and non-sexual reproduction; but although his own observations would lead him to somewhat different conclusions from those of the author of the paper, he felt it would be unfair to enter upon any lengthened criticism of its contents without having previously studied it.

The President said that the paper was manifestly one of considerable interest, throwing out, as it did, some original suggestions which would well repay investigation.

---

* See Ann. and Mag. Nat. Hist., xiii. (1884) p. 101, where Mr. Mills's discoveries are noticed by Mr. H. J. Carter, who, however, does not explicitly state that Mr. Mills has discovered three series of birotulates, but mentions his own observation of the same fact.

Prof. Bell read his paper "Notes on the Structural Characters of the Spines of the Echinoidea—Cidaridæ" (see p. 846).

Dr. Carpenter, C.B., said he must confess that he did not at present clearly understand Prof. Bell's meaning as conveyed in this paper. The spines of the ordinary *Echini*, whenever they were not annual spines—which were shed and renewed every year—presented certain well recognized features. In the large spines of the many tropical forms, they had in the transverse sections a series of well-marked rings of growth resembling the annual rings of the trunk of a tree, and these might go on increasing indefinitely because every new growth was added in the same way. But in the *Cidaridæ* there was nothing of the kind; there the whole interior of a spine seemed to be formed continuously, so that the cylindrical interior contained passages prolonged from the internal passage or solid network which was occupied by a protoplasmic substance. Now, when that kind of sheath was first formed he did not deny that it might increase up to a certain point, but he had yet to be informed that the interior continued to undergo an increase after the external portion had become hardened. They knew perfectly well now how lines were enlarged, and that there was a process going on there of continual removal of old matter and the addition of new. The old notion of interstitial swelling out was now given up, and he could not think of it as going on in the case of a spine. The only other mode of increase would be by the removal of the interior portion of the sheath and by addition to the external portion. So far as his observations went he could see no evidence that when the cylinder had once been encased by this nearly solid sheath, the internal portion of the spine underwent any increase.

Prof. Stewart said that so far as regarded the spines of the *Cidaridæ* his observations entirely tended to show that having once become invested with this calcareous sheath, the vitality of the spine was so lowered thereby that it allowed of the accumulation of parasites of all descriptions which infested these spines and these only. The process of investment amounted in fact to an arrest of growth. By means of a drawing on the black-board he showed that these spines were increased by additional layers being added to them, after which they became encrusted and *Serpulæ*, &c., became attached to them. In the *Goniocidaridæ* there was less liability to this.

Dr. Carpenter said that his experiences on these points entirely coincided with those of Prof. Stewart.

Prof. Stewart further said that wherever the spines were found in frictional contact with each other the interstices would be seen to be filled up with calcareous matter, just as similarly occurred when two portions of bone were in contact in cases of osteo-sclerosis.

Prof. Bell said he was sure that the meeting would understand that he had made himself acquainted with what had been done on these subjects by Dr. Carpenter and Prof. Stewart, but what troubled him to understand was how if the adult spine had a certain amount of incrustation, the crust should be proportionately thinner in the larger than in the smaller specimens. He had carefully examined

and measured the proportionate diameters of the outer and inner portions, and from the figures given it was clearly shown that the larger spines had the thinner crust. It was also found by taking measurements from various parts of the spine that the wearing down was not confined to the points. He was not prepared, however, to give an answer as to how the interior of the spine increased in size, though it was shown that in a full-grown specimen the interior cavity was not diminished by the fact that it had a comparatively thick crust. With regard to the growth of parasites, that necessarily had to be taken into consideration as a matter of some importance, and though of course he did not pretend to put his experience against that of Dr. Carpenter or Prof. Stewart, he might say that if he had to base his experience upon the large collection in the British Museum, he should not have been struck with the amount of parasitism apparent there. The crust had had ascribed to it a determining influence upon the growth of the spine, but he ventured to think that the figures which he had drawn gave a somewhat different aspect to the question from that which had been hitherto accepted.

Dr. J. D. Cox's paper "On Some Photographs of Broken Diatom Valves, taken by Lamplight," was read (see p. 853), and the photographs accompanying it were handed round for inspection.

Mr. J. Mayall, jun., and Mr. Crisp called attention to the points in the photographs establishing Dr. Cox's views.

Mr. Lewis Wright exhibited in operation and described a new lantern Microscope which, after considerable study and attention, he had been successful in bringing to a degree of perfection which he believed had not hitherto been attained. The want of some apparatus of the kind capable of exhibiting minute objects under high powers and free from distortion or colour had long been felt, and he had been urged by several Fellows of the Society to turn his attention to the matter on account of the great value to lecturers and others of some really good optical arrangement which would enable microscopical preparations to be properly shown to a large number of persons at the same time. Dr. Carpenter had suggested to him to take the tongue of a blow-fly, as prepared by Mr. Topping, and to work upon that as a test object, and Mr. Curties had told him that what was wanted was an apparatus which would show the tongue of the blow-fly six feet long. He had placed the mechanical arrangements in the hands of Mr. Herbert C. Newton, who had carried them out in a way which left little or nothing to be desired. The lantern employed was an ordinary one, the lime-light being used for illumination. As regarded the objectives, he need hardly say that perfection in these was of the first importance, particularly in the case of the higher powers, as many a lens which seemed to work very well upon the ordinary Microscope would completely break down under the strain

put upon it by this very severe test of its capabilities. The best 1/2-inch objective of many which he had tried was one by Powell & Lealand, which Mr. Crisp had lent him, and which worked in a most admirable manner. An objective of similar power by Gundlach had also been lent him by Mr. Curties, and the excellent qualities of this lens were brought out in a very remarkable degree. He was also greatly indebted to Mr. Topping and others for the specially beautiful slides which had been placed at his disposal, and which he proposed to exhibit, together with some prepared by Dr. Carpenter. The lights being lowered,

Mr. Wright then exhibited upon a screen the following series of objects, commencing with those of large size under a comparatively low power, and afterwards employing an 8/10 in., and the 1/2 in. objectives referred to, both with and without amplifiers. It was specially remarked that the images were shown with perfect sharpness of definition up to the very margin of the field:—Scorpion-fly; larva of vapourer moth; wood of elm; hand of monkey; human thumb; kidney, double-stained and injected; foot of *Dytiscus;* eye of dune fly; human tongue; cat's tongue; brain; *Echinus* spine (3); intestine of cat; coiled palate of limpet; tongue of blow-fly; circulation in foot of living frog.

At the conclusion of the exhibition, which prolonged the meeting to a later hour than usual, but appeared to give great satisfaction to the large number of Fellows present,

The President said that no doubt most of them had at some time felt the need of means by which they might be able to project objects with some degree of clear definition, and he was himself very thankful for the progress which had been made by Mr. Wright in this direction. He thought the successful results of Mr. Wright's efforts pointed to the attainment of even still greater success in the future.

Dr. Carpenter had great pleasure in moving a vote of thanks to Mr. Wright for his very interesting exhibition. He had been in communication with him during the progress of his experiments, and had been much pleased to see how great the success had been. He had never seen such definition at any exhibition of the kind before. For educational purposes, it was a matter of great importance and value to be able to show the real objects in this way.

Prof. Stewart said that what they had seen had been shown in such a really sharp and excellent manner that Mr. Wright was to be much congratulated upon his success, and the more especially so that most of the objects which had been exhibited in such an exceedingly satisfactory way had not been prepared for the purpose.

Mr. Michael said that the exhibition was a great step in advance of anything which had hitherto been accomplished. Although the perfection of detail brought out might not equal the definition under an ordinary Microscope it was of the greatest value in enabling any one to show objects with such perfection to a large audience at one time. He had great pleasure in seconding the vote of thanks.

Mr. Crisp said that the improvement in definition obtained by Mr. Wright over that of the "Giant Electric Microscope" exhibited last

year was very marked, and showed the value of what he had accomplished.

The President put the vote to the meeting, and declared it carried unanimously.

The First Conversazione was announced for the 26th inst.

The following Instruments, Objects, &c., were exhibited:—

Prof. Bell:—Transverse sections of spines of Cidaridæ, *Salenia* and *Echinocidaris*, illustrating his paper.

Mr. Bolton:—(1) *Vorticellæ* (? sp.); (2) *Syncoryne frutescens*.

Dr. J. D. Cox:—Photographs of Diatoms, illustrating his paper.

Mr. Crisp:—(1) Foot & Son's New Compound Microscope (4*s.* 6*d.*); (2) Fasoldt's Nose-piece; (3) Osborne's Diatomescope.

Rev. Metcalfe Gray:—Ether Freezing Microtome, and two sections of cancer cut with it.

Dr. Maddox:—(1) Miquel's Culture Slide; (2) Sterilized gelatinized paper.

Mr. J. Mayall, jun.:—(1) Swift Microscope with double "stepped-rack" and improved limb; (2) Bertrand Polarizing Prism.

Dr. Van Heurck:—*Amphipleura pellucida* mounted (1) in H. L. Smith's medium, Index 2·25, and (2) in Van Heurck's medium, Index 2 (*ante*, p. 656).

Mr. F. H. Ward:—Section of human spinal cord from a case of Syringo-myelus.

Mr. H. G. A. Wright:—Proboscis of Blow-fly showing the structure described in his letter.

Mr. L. Wright:—Lantern Microscope and the objects enumerated *supra*.

New Fellows:—The following were elected *Ordinary* Fellows:—Messrs. Augustus C. Bernays, A.M., M.D., J. W. Russell, R. P. Hart Durkee, B.L., Albert B. Hole, A. Longbottom, G. E. Mainland, P. C. Nixon, F. A. Parsons, John Rhodes, W. X. Sudduth, M.D., and the Rev. A. V. Miller, B.D. Prof. W. Kitchen Parker was elected an *Honorary* Fellow.

INDEX.

*** The Index includes the names of the Authors of all Papers, &c., printed in the "Transactions," or noted in the "Summary" or Bibliography, as well as those of the Designers of any Instruments or Apparatus described under the head of "Microscopy."

C.

E.

F.

G.

H.

N.

Q.

R.

T.

LONDON: PRINTED BY WILLIAM CLOWES AND SONS, LIMITED, STAMFORD STREET AND CHARING CROSS.

THE ROYAL MICROSCOPICAL SOCIETY.

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

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

It consists of Ordinary, Honorary, and Ex-officio Fellows.

Ordinary Fellows are elected on a Certificate of Recommendation signed by three Fellows, stating the names, residence, description, &c., of the Candidate, of whom one of the proposers must have personal knowledge. The Certificate is read at a Monthly Meeting, and the Candidate balloted for at the succeeding Meeting.

The Annual Subscription is 2*l.* 2*s.*, payable in advance on election, and subsequently on 1st January annually, with an Entrance Fee of 2*l.* 2*s.* Future payments of the former may be compounded for at any time for 31*l.* 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 absent from the United Kingdom for a year, or permanently residing abroad, are exempt from one-half the subscription during absence.

Honorary Fellows (limited to 50), consisting of persons eminent in Microscopical or Biological Science, are elected on the recommendation of three Fellows and the approval of the Council.

Ex-officio Fellows (limited to 100) consist of the Presidents for the time being of such Societies at home and abroad as the Council may recommend and a Monthly Meeting approve. They are entitled to receive the Society's Publications, and to exercise all other privileges of Fellows, except voting, but are not required to pay any Entrance Fee or Annual Subscription.

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

The Meetings are held on the second Wednesday in each month, from October to June, in the Society's Library at King's College, Strand, W.C. (commencing at 8 P.M.). Visitors are admitted by the introduction of Fellows.

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, with a Summary of Current Researches relating to Zoology and Botany (principally Invertebrata and Cryptogamia), Microscopy, &c., is published bi-monthly, and is forwarded *gratis* to all Ordinary and Ex-officio Fellows residing in countries within the Postal Union.

The Library, with the Instruments, Apparatus, and Cabinet of Objects, is open for the use of Fellows daily (except Saturdays), from 10 A.M. to 5 P.M., and on Wednesdays from 7 to 10 P.M. It is closed during August.

Forms of proposal for Fellowship, and any further information, may be obtained by application to the Secretaries, or Assistant-Secretary, at the Library of the Society, King's College, Strand, W.C.